

**A Particular Type of Cobble Spall Tool from the
Canadian Plains:**
Multi-Variant Analysis of Early-Middle Period Eldon Unifaces

A Thesis Submitted to the College of
Graduate Studies and Research
in Partial Fulfillment of the Requirements
for the Degree of Master of Arts in the
Department of Archaeology and Anthropology
University of Saskatchewan
Saskatoon, Saskatchewan

By Matthew S. Stewart

Permission to Use

In presenting this thesis in partial fulfillment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis.

Requests for permission to copy or make other use of the material in this thesis in whole or in part should be addressed to:

Head of the Department of Archaeology and Anthropology
University of Saskatchewan
Saskatoon, Saskatchewan
S7N 2A5

Abstract

Eldon unifaces are unifacially flaked stone tool artifacts that are unique to the Canadian Plains of the early-Middle Period (7,500-4,500 ya). They are unique because cortex covers the ventral side. The artifacts also have a suit of traits such as being thinned (or an attempt was made to thin), unifacially flaked, and there is a preference for them to be made from large quartzite cobbles. Further morphological traits indicate that there are four related types of these tools: Classic, Corner, Side, and Amorphous; the first two are the focus of this thesis. Design theory and Chaine Opératoire are used to study how the artifacts were made and used. Other geographic regions are sought for similar artifact forms: Manitoba, Eastern Woodlands /Maritimes, and British Columbia. It is the cobble spall tools from British Columbia that has the most striking similarity in morphology and manufacturing strategy. There are also important differences like in how Eldon unifaces are more heterogeneous and circumscribed to a shorter period of time than the British Columbia artifacts.

A morphological and usewear analysis is undertaken to ascertain the function of Classic and Corner Eldon unifaces. The morphological analysis indicates that the tools were likely used to process medium to hard materials; however, the literature is rife with contradictions on how to relate morphology with function. This questioned the reliability of a morphological approach to function and indicated that it needed to be supported by a usewear approach. The usewear analysis supported the inferences of the tools working medium to hard materials and also indicated how the tools were used (motion). Further, the usewear and morphological analyses also indicated that the Eldon unifaces were likely hafted.

Acknowledgements

To my wife, Michelle. My love for you can be found between each word printed here.

Thank you to my supervisor David Meyer. He was a wealth of knowledge and always open to new ideas. His tutorship and belief in me was and is greatly appreciated. Thank you to my committee members Ernie Walker and Urve Linnamae. Urve also donated Rocky Mountain quartzite materials and Ernie provided the Gowen site artifacts. A further thank you goes to my external Gary Zellar.

Thank you to the many people that have helped me along the way with equipment, conversations, and artifacts. Thank you to Dan Meyer and Jason Roe for their insightful conversations about everything to do with rocks! Also, thank you for providing me with the Upper Lovett Campsite artifacts. Thank you to Laura Roskowski for the HhOv artifacts; your cheer and enthusiasm for archaeology is infectious! Thank you to Jeremy Leyden for the Alberta surface find. Thank you to Barb Neal for pointing me to the Douglas Park Sandhills artifacts that you previously analyzed in your MA thesis. Thank you to Rob Peace of the University of Saskatchewan Engineering Department for providing me access to their equipment. Thank you Cara Pollio for helping me with casting artifacts. Thank you also to those I corresponded to in e-mail or in person about the artifacts I studied. Thank you to all those not mentioned here.

Thank you to the two organizations that provided me with financial support. Thank you to the Heritage Foundation as the project was partially funded by the Government of Saskatchewan through a Heritage Foundation Grant. Also, thank you to the Saskatchewan Archaeology Society, Saskatchewan Lotteries, who also partially funded this project.

Thank you to all the friends I made at the University of Saskatchewan. You all helped me in so many ways, from breaking rocks to offering me a couch to sleep on. Thank you to Denise Gibson, Tam Huynh, Alan Korejbo, Cara Pollio, Karmen VanderZwan, Kris Sullivan, Robin Szamuhel, Karin Steuber, Mike Markowski, Carrie Dunn, Jody Kobelka, Adam Splawinski, Nadia Smith, and Kelly Sayers. Thank you to Mark Ebert. Thank you also to Liz Robertson. You were a friend and a teacher, two things that are rarely found together. To those not mentioned here, I appreciate each and every one of you. Timmy runs would not have been the same.

Thank you also to those not directly involved but who provided me inspiration, confidence, and necessary distractions. Thank you to Andrew and Jody McKay. You two are always welcome distractions. Thank you to my mom and dad, Patty and Richard, and my inlaws, John and Laural. You all give me inspiration and confidence.

Lastly, to those who think you cannot. They can.

Table of Contents

Permission to Use	ii
Abstract	iii
Acknowledgments	iv
Table of Contents	vi
List of Tables	xii
List of Figures	xiii
1 Introduction	1
1.0 Thesis Components	2
2 Four Kinds of Eldon Unifaces	5
2.0 Introduction	5
<i>Previous Names</i>	5
<i>Orientation /Description</i>	7
<i>Naming</i>	9
2.1 Eldon Uniface Types	11
2.1.1 Classic	15
2.1.2 Corner	17
2.1.3 Side	19
2.1.4 Amorphous	20
2.2 Discussion	21
2.3 Conclusion	23
3 Context	24
3.0 Introduction	24
3.1 Middle Period	24
<i>Climate</i>	25
<i>Subsistence</i>	26

	<i>Technology</i>	27
3.2	Site Context: Plains	28
3.2.1	Saskatchewan Samples Context	28
	<i>Below Forks site (FhNg-25)</i>	28
	<i>Dog Child site (FbNp-24)</i>	30
	<i>Lake Diefenbaker sites (EgNp-63 & EgNq-18)</i>	31
	<i>Gowen (FaNq-25 & FaNq-32)</i>	35
	<i>Douglas Park Sandhills Sites (EgNn-9 & EgNo-23)</i>	36
	<i>Surface Collections, Various Locations</i>	38
3.2.2	Alberta Samples Context	40
	<i>Upper Lovett Campsite (FgQf-16)</i>	41
	<i>Stampede Site (DjOn-26)</i>	43
	<i>Boss Hill site (FdPe-4)</i>	44
	<i>Anderson site (FdOt-1)</i>	46
	<i>Southeast Alberta Surface Find</i>	46
	<i>Boreal Forest of Northern Alberta</i>	
	<i>Sites (HhOv-483 & 484 sites)</i>	46
3.2.3	Limited to Only Saskatchewan & Alberta?	50
3.2.4	Limited Similarities	50
3.3	Similarities to Other Geographic Regions	54
3.4	Northwest Coast - Interior British Columbia	63
	<i>Geographical Region and Date</i>	64
	<i>Description</i>	66
	<i>Function</i>	68
3.5	Conclusion	72
4	Steps and Separations	75
4.0	Introduction: How and What	75
4.1	Design Theory	75
4.2	Sequence Models of Eldon Unifaces	77
	<i>Experimental Archaeology /Flintknapping</i>	78

	<i>Sequence Models /Chaine Opératoire</i>	79
4.3	Manufacturing Steps of Eldon Unifaces	82
4.3.1	Raw Material Acquisition: Characterization of Quartzite	83
	<i>Advantages & Disadvantages: Constraints</i>	89
	<i>Control & Meaning</i>	91
4.3.2	Flaking /Splitting Cobbles	93
	<i>Free-Hand Technique</i>	93
	<i>Heating /FBR Technique</i>	96
	<i>Bipolar Technique</i>	97
	<i>Examples of the Bipolar Technique</i>	
	<i>from other Geographical Regions</i>	99
	<i>Experimental Recreation /Flintknapping</i>	101
4.3.3	Edge Modification	105
	<i>Details & Inferences on Edge Modification</i>	106
4.3.4	Resharpener Strategies	110
	<i>Quantifying Curation</i>	113
4.4	Why cortex?	122
4.5	Context of Manufacturing: Skill & Gender	125
	<i>Sex & Gender</i>	125
	<i>Traces of Skill</i>	126
4.6	Discussion /Conclusion	129
5	Function I: Morphology	132
5.0	Introduction	132
5.1	Dimensions of Eldon Unifaces:Methodology	132
	<i>Patterns in the General Data</i>	134
5.2	Function through Morphology	136
5.2.1	Edge Shape	138
	<i>Distal Edge Characterization</i>	138
	<i>Edge Thickness</i>	141

	<i>Edge Shape</i>	142
	<i>Edge Width</i>	142
	<i>Case for Eldon Uniface Function as Based on Edge Morphology</i>	144
5.2.2	Edge Angles	144
	<i>Bone & Woodworking</i>	146
	<i>Hide Working</i>	148
	<i>No Particular Task</i>	152
	<i>The Case for Eldon Uniface Function as Based on Edge Angle</i>	152
5.3	Proximal Morphology: Hafting vs. Prehensile Manipulation	157
5.3.1	Hafted Tools?	157
	<i>Advantage to Hafting</i>	157
	<i>Description of Handle Types: Open vs. Closed-Socket</i>	158
	<i>Material</i>	159
	<i>Resins, Mastics & other Bindings</i>	160
	<i>Alterations to the Tool</i>	161
	<i>Use Evidence of Hafting</i>	163
5.3.2	Unhafted Tools?	165
5.3.3	Were Eldon Unifaces Hafted?	166
5.4	Conclusion	168
6	Function II: Usewear	170
6.0	Introduction	170
6.1	Definition of Usewear	170
6.2	Analogy in Usewear Studies	172
6.3	Methodologies	174
6.4	Artifact Usewear Observations	178
6.4.1	Alberta Boreal Forest: HhOv-483 & HhOv-484	179
6.4.2	Western Alberta: FgQf-16	184
6.4.3	West-Central Saskatchewan: Gowen Sites	196

6.4.4	South-Central Saskatchewan: EgNp-63, Aitkow 3 site	202
6.4.5	South-Central Saskatchewan: EgNn-9	205
6.5	Discussion /Conclusion	205
7	Conclusion	216
	<i>Future Directions</i>	220
	References Cited	223
	Appendix	
A.1	Usewear Definitions	246
A-1.0	Introduction	246
	<i>Butchering</i>	247
	<i>Cutting</i>	247
	<i>Scraping</i>	247
	<i>Chopping</i>	248
	<i>Graving /Boring</i>	248
	<i>Projectile Points</i>	249
	<i>Hafting</i>	250
A-1.1	Polish	253
	<i>Lithic Material Type</i>	255
	<i>Stages of Polish Development</i>	255
	<i>Material Specific Polishes</i>	257
	<i>Material Specific Polishes: Wood</i>	257
	<i>Material Specific Polishes: Antler</i>	258
	<i>Material Specific Polishes: Bone</i>	258
	<i>Material Specific Polishes: Dry hide</i>	258
	<i>Material Specific Polishes: Flesh</i>	259
	<i>Material Specific Polishes: Soft Plant (sickle polish)</i>	259
	<i>Lubricants</i>	259

<i>Location /Action Inferences</i>	260
<i>Additive vs. Subtractive Theories</i>	261
<i>Delamination Theory</i>	262
<i>Silica-Gel Theory</i>	263
<i>Abrasive Theory</i>	265
<i>Fractal Geometry & Computer Imaging</i>	266
A-1.2 Striations	268
<i>Inference of Material Type</i>	269
<i>Inference of Motion /Environment /Hafting</i>	270
A-1.3 Microchipping	272
<i>According to Material Type</i>	274
A-1.4 Rounding	276
A-1.5 Caveats of Usewear Studies	278
<i>Identifying Non-Intentional Trauma</i>	278
<i>Soil Trauma</i>	280
<i>Trampling</i>	281
<i>Tool Creation vs. Tool Use</i>	282
<i>Contemporary Culture Induced Trauma</i>	283
<i>Differences of Stone Types</i>	283
<i>Raw vs. Cooked Stone</i>	286

List of Tables

Ch.3

3.1	List of artifact types from EgNq-18 (N=131)	35
-----	---	----

Ch.4

4.1	Tool Constraints (modified from Morin 2004:299)	77
4.2	Compilation of recorded colors for Eldon unifaces	87-88
4.3	MOHs Scale	89

Ch.5

5.1	Eldon uniface metric attribute averages	137
5.2	Morphological traits of Eldon uniface	141
5.3	Edge angles with associated task, according to the literature	147
5.4	Edge Angles organized by mean, and arranged by site and total number	154

List of Figures

Ch.1

1.1	Classic style of an Eldon uniface from EgNp-63 No.1	1
1.2	Location of archaeological sites with Eldon unifaces	2

Ch.2

2.1	Loafing core from FgQf-16	7
2.2	An endscraper from Saskatchewan surface collection	8
2.3	A Classic Eldon uniface with orientation labeled	9
2.4	Arrangement of how the Eldon uniface types are related to each other and utilized split pebbles	12
2.5	Two unmodified split pebbles	14
2.6	Two Classic Eldon unifaces	16
2.7	Corner Eldon Uniface (EgNp-63)	18
2.8	An irregular-rectangular shaped Corner Eldon Uniface, with orientation (Gowen site)	19
2.9	Side Eldon uniface (Alberta surface find)	20
2.10	Amorphous Eldon uniface (Saskatchewan surface collection)	21

Ch.3

3.1	Location of sites with Eldon unifaces	29
3.2	Artifacts from the Below Forks site, Saskatchewan	30
3.3	Domed scraper from the Dog Child site	31
3.4	Eldon unifaces from EgNp-63	33
3.5	Eldon unifaces from the Gowen site	37
3.6	Eldon uniface from EgNo-23	38
3.7	Three Corner Eldon unifaces from Saskatchewan surface collection	39
3.8	Six Classic Eldon unifaces from Saskatchewan surface	

collection	40
3.9 Location of sites discussed below in Alberta	41
3.10 Eldon uniface from FgQf-16	42
3.11 Two large chipped stone tool from the Boss Hill site	45
3.12 Side Eldon uniface from disturbed context near Oyen, Alberta	47
3.13 Classic Eldon uniface from HhOv-484	48
3.14 Lac La Biche artifacts	49
3.15 Percentage of total Eldon types across Saskatchewan	52
3.16 Percentage of total Eldon types from EgNq-18	52
3.17 Percentage of total Eldon types from FaNq-25 and FaNq-32	53
3.18 Percentage of total Eldon types from EgNp-63	53
3.19 Percentage of total Eldon types from Saskatchewan surface collections	54
3.20 Chipped and ground adze blade from the Pinawa Bridge site	55
3.21 Three different adze blades from Manitoba	57
3.22 Chipped stone adze blade from the Coca-Cola Creek site	58
3.23 Chisel adze blade	60
3.24 Eldon unifaces from EgNq-18 that share some similarities with Trihedral adzes from Manitoba	62
3.25 Cobble spall tools from Keatley Creek site	66
3.26 Tahltan hafted cobble spall tools	69
3.27 Tahltan cobble spall tool used for hide processing	70

Ch.4

4.1 Naturally eroding quartzite cobbles in southwestern Saskatchewan near the Cypress Hills	84
4.2 Quartzite cobbles eroded near fence line in southwestern Saskatchewan near the Cypress Hills	85
4.3 Stepped scars along a core's platform from incorrect striking	94
4.4 Multiple crushed areas near the tool's edge /platform	95

4.5	Reddened Eldon uniface from the UofS teaching collection	97
4.6	Split cobble from the cairn method	103
4.7	Experimentally bipolarly struck core on anvil without brace	104
4.8	Overlapping flake scars on left distal corner of Eldon uniface from EgNp-63	109
4.9	Knot on distal area of a Classic Eldon uniface from EgNp-63, flanked by step terminated flaked scars	110
4.10	Celt from EgNp-63	112
4.11	Comparison of weight and edge angles of Classic Eldon unifaces	115
4.12	Width and length values (cm) for Eldon unifaces, as organized by type	116
4.13	Comparison of length and widths of Classic Eldon unifaces as separated by site /collection	117
4.14	Comparison of thicknesses recorded from three areas on a Classic Eldon uniface and individually compared with the central (maximum) length	118
4.15	Possible removed working edge of Eldon uniface in a burin-like manner	119
4.16	An example from FgQf-16 (no. 76) of a tool with the distal edge removed	120

Ch.5

5.1	Placement of measurements on a generalized image of an Eldon uniface	133
5.2	Comparison of central length and central thickness of Eldon types	134
5.3	Comparison of distal widths and distal edge angles according to type	135
5.4	Comparison of average individual weight of an Eldon type	136
5.5	<i>U</i> shaped distal mouths on Classic Eldon unifaces	139

5.6	Distal edge shape outlines of Eldon unifaces	140
5.7	Central lengths of Classic Eldon unifaces as compared to distal edge angles to test if edge angles changed from resharpening	146
5.8	Recorded edge angles from planer tools used by New Guinea aboriginals	148
5.9	Comparison of edge angles versus weights of planer tools recorded in a New Guinea aboriginal group	149
5.10	Comparison of Classic Eldon unifaces versus New Guinea planers for their edge angles and weights	149
5.11	Comparison of edge angles and their corresponding thickness on Corner Eldon unifaces	155
5.12	Comparison of distal thickness and edge angles according to Eldon type	155
5.13	Comparison of distal widths and distal edge angles according to Eldon type	156
5.14	Comparison of central lengths (maximum) versus distal edge angles for Eldon types	156
5.15	Comparison of the width and thickness at the distal region of Eldon unifaces. Data is separated by type	162
5.16	Comparison of the width and thickness at the central region of Eldon unifaces. Data is separated by type	162
5.17	Comparison of the width and thickness at the proximal region of Eldon unifaces. Data is separated by type	163
5.18	Comparison of the width and thickness at the distal, central, and proximal regions of Eldon unifaces	164
5.19	Three cross-section shapes of hafted tools	164
5.20	Tapering of the proximal end of a Classic Eldon uniface from FgQf-16	167

Ch.6

6.1	Artifacts from FgQf-16 with drying dental cast material	178
6.2	Usewear map of No.14 from HhOv-483 (6.2a-6.3g)	180
6.3	Usewear map of No.15 from HhOv-484 (6.3a-6.3g)	181
6.4	Polish (40x) on proximal edge of No. 14	182
6.5	Polish from ventral face of Eldon Uniface no.15, HhOv-484	183
6.6	Usewear map of No. 76 from FgQf-16 (6.6a-6.6e)	185
6.7	Polish seen from three different magnifications of FgQf-16, No.17	187
6.8	Usewear map of No.65 from FgQf-16 (6.8a-6.8d)	189
6.9	Three images of polish as located in Figure 8.14	190
6.10	Usewear map of No. 73 from FgQf-16 (6.10a-6.10b)	191
6.11	FgQf-16 No.71	192
6.12	FgQf-16, No.66	193
6.13	Three images of polish in the proximal region of No.66, FgQf-16	194
6.14	Three images of polish along the distal edge of No.66, FgQf-16	195
6.15	Dorsal surface of a Classic Eldon uniface from the Gowen site, No. 148	197
6.16	Ventral surface of Classic Eldon uniface from the Gowen site, No. 148	197
6.17	Striations on the flattened distal edge of No.148 (FaNq-25-145-327)	198
6.18	Acetate peel of the flattened and striated distal edge of Eldon uniface No.150	199
6.19	Striations on Eldon uniface from Gowen site, No. 118	200
6.20	Usewear map of No.40 from EgNp-63 (6.20a-6.20c)	203
6.21	Rounded and crushed projection along No.6	204
6.22	Usewear map of No.56 from EgNn-9 (6.22a-6.22c)	206
6.23	Eldon uniface movement and two possible hafting styles	207

6.24	Hafting style of Classic Eldon unifaces	211
6.25	Hafting style for Corner Eldon unifaces	213

Chapter 1

Introduction

“This inquiry I must confesse is a gropeing in the Dark: but although I have not brought it into a cleer light; yet I can affirm, that I have brought it from an utter darkness to a thin Mist; and have gone farther in this Essay than anyone before me...these Antiquities are so exceeding old, that no Bookes doe reach them, so that there is no way to retriue them but by comparative antiquitie, which I have writt upon the spott from the monuments themselves.” (John Aubrey In Burl 2007:4)

Eldon unifaces are a unique stone tool from the Canadian Plains (an example of these artifacts is depicted below in figure 1.1). These artifacts are defined and characterized in this thesis. Walker (1992:55-58) and Kasstan (2004:126-127) are two previous authors who briefly discussed Eldon unifaces, although they referred to the artifacts as ‘gouges’ or ‘reverse unifaces’. The inferences presented by these two authors about Eldon unifaces is tested and elaborated on. The aspects of Eldon unifaces discussed here consist of morphology, method of manufacture, location, dates, and function.



Figure 1.1 Classic style of an Eldon uniface from EgNp-63 No.1. Both images of the same artifact: cortex surface (ventral) right, flaked surface (dorsal) left.

Like Aubrey’s above passage, I realize that this discussion on Eldon unifaces is not definitive; there is always more to learn. Nor does this thesis consider every variable.

Instead, this thesis offers a starting point for the understanding of Eldon unifaces and encourages further research in unifaces on the Canadian Plains in more general.

1.0 Thesis Components

Eldon unifaces are hafted unifacial stone tools known from the Plains of southwestern Saskatchewan and across much of Alberta (Figure 1.2 depicts site locations). Most are made from quartzite cobbles. The cortex is always retained on one side and they date to the early-Middle Period. The artifacts were likely used to plane wood. These artifacts have received different names in the past, but are referred to here as Eldon unifaces, after the late Eldon Johnson. Four different varieties of these artifacts are identified through

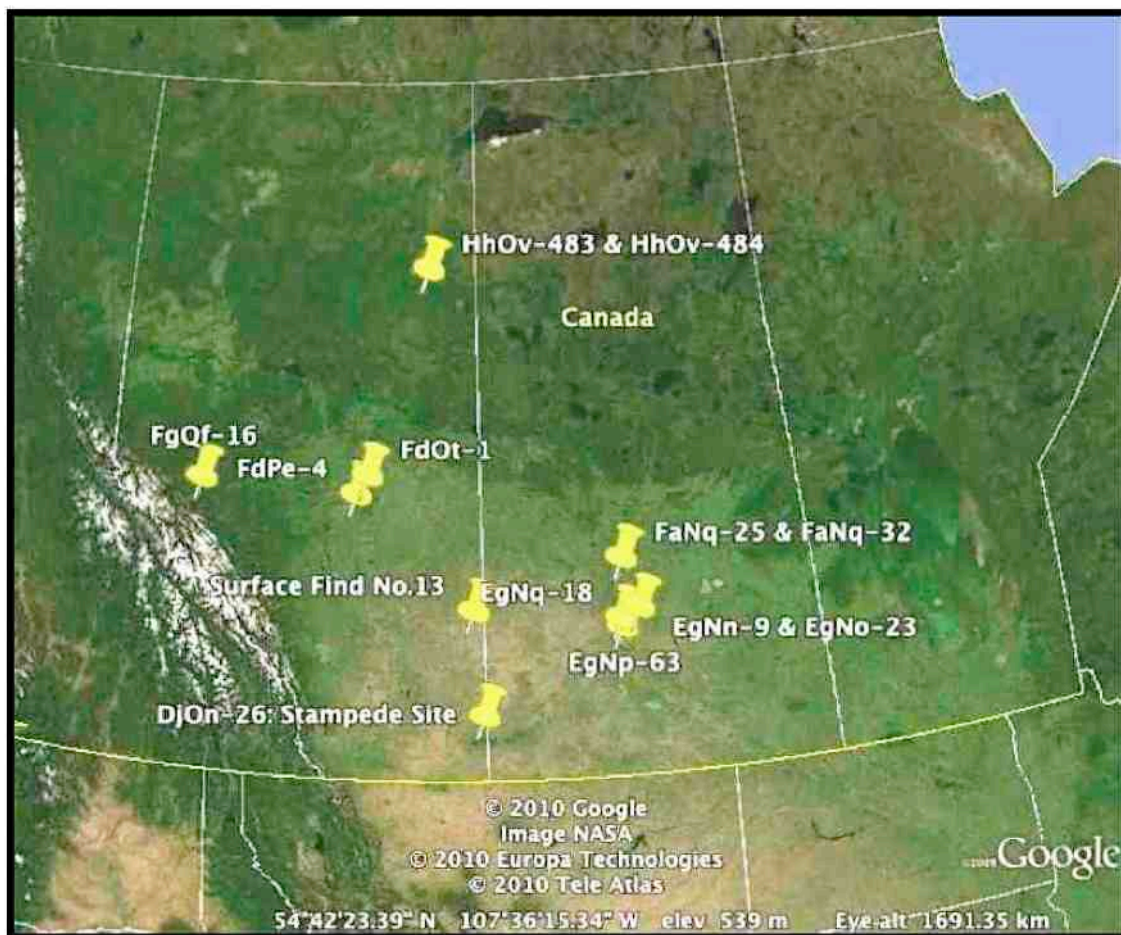


Figure 1.2 Location of archaeological sites with Eldon unifaces (created on Google Earth 5).

isolating the artifact's attributes: Classic, Corner, Side, and Amorphous. These variations have some overlap and it is the first two of these that are focused on for much of this thesis. The types of Eldon unifaces, how they are orientated, and an argument for why they are named Eldon unifaces are presented in Chapter 2.

Eldon unifaces are known from southwestern Saskatchewan and adjacent Alberta. This geographical span is based on the artifact collections studied in this thesis. The sites these collections were obtained from are discussed in Chapter 3, along with other sites encountered in the archaeological literature that may also have Eldon unifaces. Not all of these sites have associated dates, but those that do fall in the early-Middle Period. This time span is discussed alongside the description of the sites. The association of a uniface to a particular period of time is contrary to the opinion of some authors, as in the case of the Alberta boreal forest, "artifacts other than pottery and projectile points were not used for phase definition since they tend to extend over cultural, temporal, and spatial boundaries" (McCullough 1982:12). Moreover, similar artifact forms from Manitoba, Atlantic Canada, and British Columbia are examined. The latter region is of particular importance for a seemingly identical artifact form is found there. This morphological similarity is complemented by likenesses in the archaeological sites that the artifacts have been found at, although there are differences in age and variability in form. These likenesses might indicate a similar technological solution to a given problem and perhaps cultural interaction(s).

How Eldon unifaces are constructed is discussed in Chapter 4. It is argued there are four steps to making Eldon unifaces: (1) obtaining cobbles, (2) bipolarly spalling cobbles, (3) removing thinning and shaping flakes, and (4) sharpening the edges. Pressure flakers are likely not used during any of these steps. A bipolar method is promoted although the stones may have been briefly heated as this can also spall flakes from a cobble. Another component to this chapter is a discussion about curation of Eldon unifaces, why cortex was retained, and how skill is involved in the production of these artifacts.

The function of these tools is addressed in two manners. Morphology is a traditional method used to infer an artifact's function. This approach is discussed in Chapter 5. The results of this study are mixed, but point to the Classic and Corner

variations as being hafted. The second approach, usewear analysis, is more complex and is discussed in Chapter 6. Its results indicate that the Classic and Corner variations were used to plane a material at an angle that supports the earlier notion of the artifacts being hafted. The usewear analysis also indicates that Eldon unifaces were used to work a medium to hard material such as wood or dried hide. Furthermore, Appendix A provides a reference for describing wear traces and some of the issues within identifying wear traces. This acts a reference of clarification in Chapter 6.

This thesis provides only a brief exploration of the ethnoarchaeological /ethnohistorical literature in search of Eldon unifaces or other similar stone tools. More thoroughly the archaeological *white* (published) and *grey* (unpublished professional reports) literature was searched. Archaeologists (both academic and consulting) from across Ontario to British Columbia were asked for their opinions on where ‘reverse’ unifaces were found, their function, and how they were created. This thesis makes no attempt to identify all archaeological sites with Eldon unifaces, and nor does it list all sources in the literature that mention them. But this thesis does offer a large compilation of data about these artifacts that had not been presented or thoroughly discussed before.

The author has made numerous illustrations that are used in the following chapter. The illustration of these artifacts proved insightful as it forced the eye to concentrate on features that could be easily glossed over. How the artifacts were illustrated also changed throughout this project. This change centered on how the perspectives of an artifact (dorsal and ventral) were arranged. One of the initial observations made about these artifacts was that it was important to discuss and illustrate multiple sides of these tools. This is because not all of the artifacts were constructed the same way and the only way to show this was to illustrate the distal, proximal, and both lateral sides, along with the dorsal and ventral surfaces. How these five orientations were arranged changed as different ideas on how to best perform this were encountered. Another method of viewing the artifacts was to draw a contour map of the artifact’s dorsal surface to depict the high spots and steep sides. Not all of the artifacts received this last treatment.

Chapter 2

Four Kinds of Eldon Unifaces

2.0 Introduction

Eldon unifaces are formed tools. They are *not* expedient tools, preforms, cores, flakes, or any other such cultural material. They are tools and they are made in a standardized manner with definable and discernable patterns. They can be easily identified archaeologically, but to identify them correctly one requires a definition. This chapter provides such a definition. Further, the below discourse differentiates Eldon unifaces into four kinds: Classic, Corner, Side, and Amorphous Eldon unifaces. These four kinds all share a number of morphological traits, making the four kinds overlap to a certain degree. This is akin to how Boast (1997) organized artifact types, where he wrote that each group somewhat overlapped with the next like a penumbra, or overlapping shadows. In Boast's terms, he called these fuzzy categories.

The initial section of this chapter discusses how Eldon unifaces have been misidentified in the past. Secondly, the orientation of Eldon unifaces is presented. Why the name Eldon unifaces is used is explained following this second section. Lastly, the four types of Eldon unifaces are described as they are related and yet distinct from one another. These categories were created through listing the *modes* of the artifacts (as discussed in the previous chapter, section 3.6). Further, the association of split pebble tools to Eldon unifaces is also discussed.

Previous Names

Eldon unifaces have been historically confused with other types of artifacts. This greatly hinders a study of these tools because artifacts are misidentified and terminologies differ for each researcher. This results in a communication breakdown both verbally and textually for researchers, hence the chapter's opening quote. If any future study is to be conducted on Eldon unifaces there must first be a widely accepted definition and terminology for these tools.

Gerry Oetelaar (personal communication, 2008) proposed that these artifacts were bifacial preforms where one face of a quartzite flake was worked, with the intention of

eventually flipping it over to remove material from the opposite face to form a biface. This was offered for the Strathcona site near Edmonton, Alberta, that dates from the Middle to Protocontact period (Oetelaar 1995).

Bob Dawe (personal communication, 2009) recommended that these tools were instead cores. Dawe might be confused. Coeval in time with Eldon unifaces is a similar artifact class called a *loafing core* (Vivian et al. 2008:110; Dan Meyer personal communication, 2009). Loafing cores are produced on oblong quartzite cobbles that are bipolarly struck as they are positioned on a stone anvil; one such artifact was found at the FgQf-16 site and is depicted in Figure 2.1. These cores are consistently turned as regularly shaped flakes are continually removed from the ventral surface. Loafing cores have been found with Eldon unifaces that date to the Bitterroot complex at both the Stampede (Vivian et al. 2008) and EgNq-16 sites. Loafing cores have also been called *slicing* cores and were recorded at sites in the Edmonton region (Vivian et al. 2008)). It seems that their geographical distribution is limited to the province of Alberta. These cores were defined at the Stampede site as follows

“...the removal of spalls or flakes parallel to the split face of a split cobble rather than perpendicularly to the split face. The resultant debitage will characteristically have 100 percent or very close to complete cortex on the striking platform, a relatively diffuse bulb of percussion, a thicker cross-section, and can have a relatively complex dorsal scar pattern. Loafing is in many ways comparable to bipolar percussion in that a hard rest or an anvil are required to seat the core and a hard hammer percussor would be needed to produce the spalls or flakes.” (Vivian et al. 2008:110).

This description by Vivian et al. is similar to that of *rod-shaped* cores found at Middle Pleistocene sites in the United Kingdom (Gowlett et al. 2005:21). These rod-shaped cores had fewer flake scars than spherical cores and flake scars were evident on both faces of the core with cortex covering the sides of the circular /rod-shaped cores. These UK cores were likewise similar to those used in a *salami-slice* technique found at other Mousterian assemblages. The retention of cortex along the edge of both the flakes and core is further similar to that described by Oetelaar (1995) at the Strathcona site near Edmonton Alberta. The purpose of discussing European assemblages is not to make a link between Old and New World prehistory, but rather to illustrate the point that this form of technology has been recorded in other parts of the world.

Exhausted loafing cores can be confused with Eldon unifaces since they have flake scars surrounding the perimeter with the artifact having a circular shape and one face covered in cortex. The similarities end here however. Eldon unifaces instead have a noticeable working edge. The flake scars along the edge are patterned and smaller than those on loafing cores. Eldon unifaces are likewise rarely circular in shape; there is only one example in the research collection of a circular Eldon uniface.

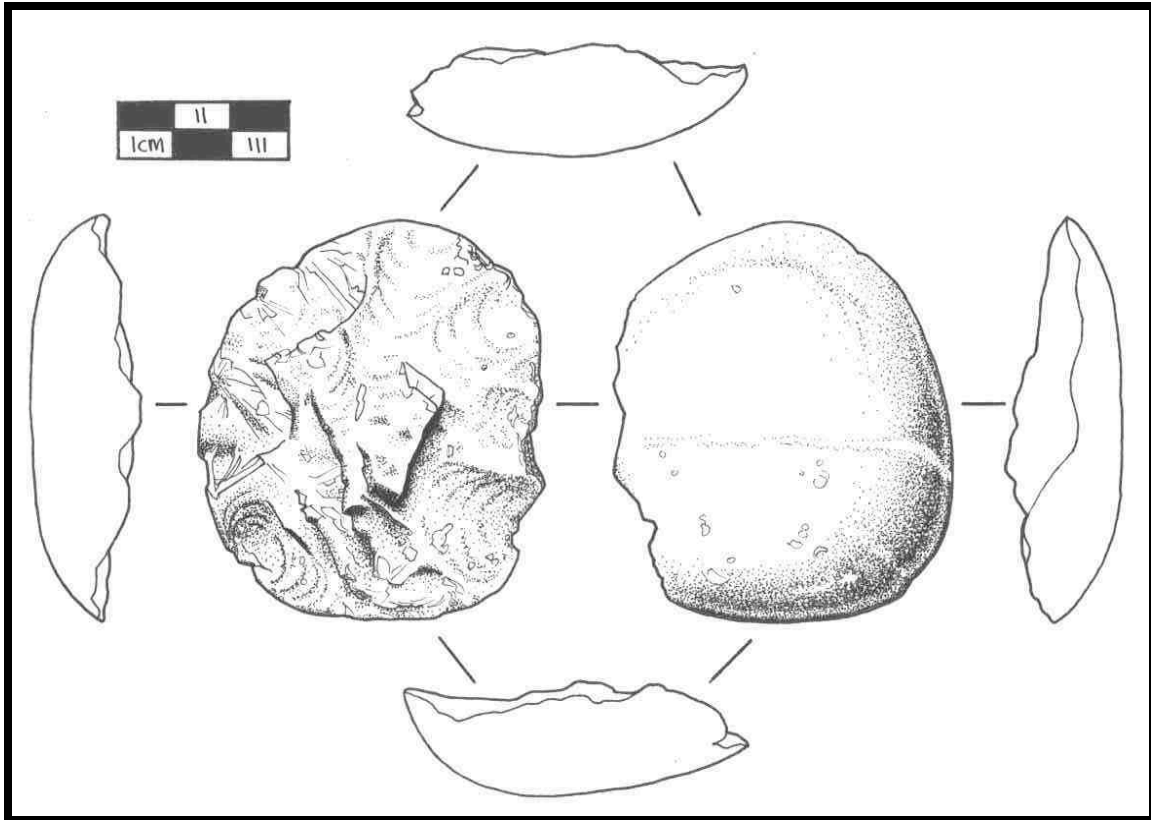


Figure 2.1 Loafing core from FgQf-16.

Orientation /Description

The orientation of Eldon unifaces is important because it differs from other unifaces. Commonly if cortex remains on a uniface it is found on the dorsal surface, the opposite of Eldon unifaces. The orientation for an endscraper is shown in Figure 2.2 as a comparison for Figure 2.3 that depicts the orientation for a Classic Eldon uniface. The retention of cortex is a defining feature of Eldon unifaces, but this does not make the artifacts unique in Saskatchewan and Alberta by itself. Eldon unifaces also have modified edges. It is this combination of modified edges and cortex on the ventral surface that makes them unique.

The working edge of an Eldon uniface is flaked. This edge is not the striking platform, which is commonly retained and found on either the lateral or proximal edge. The working edge has a profile that can be steep or shallow. Lateral edges are sometimes flaked. These flaked edges often have a shallow angle. The proximal edge is rarely flaked and has a steep angle between the dorsal surface and curved ventral /cortex surface.

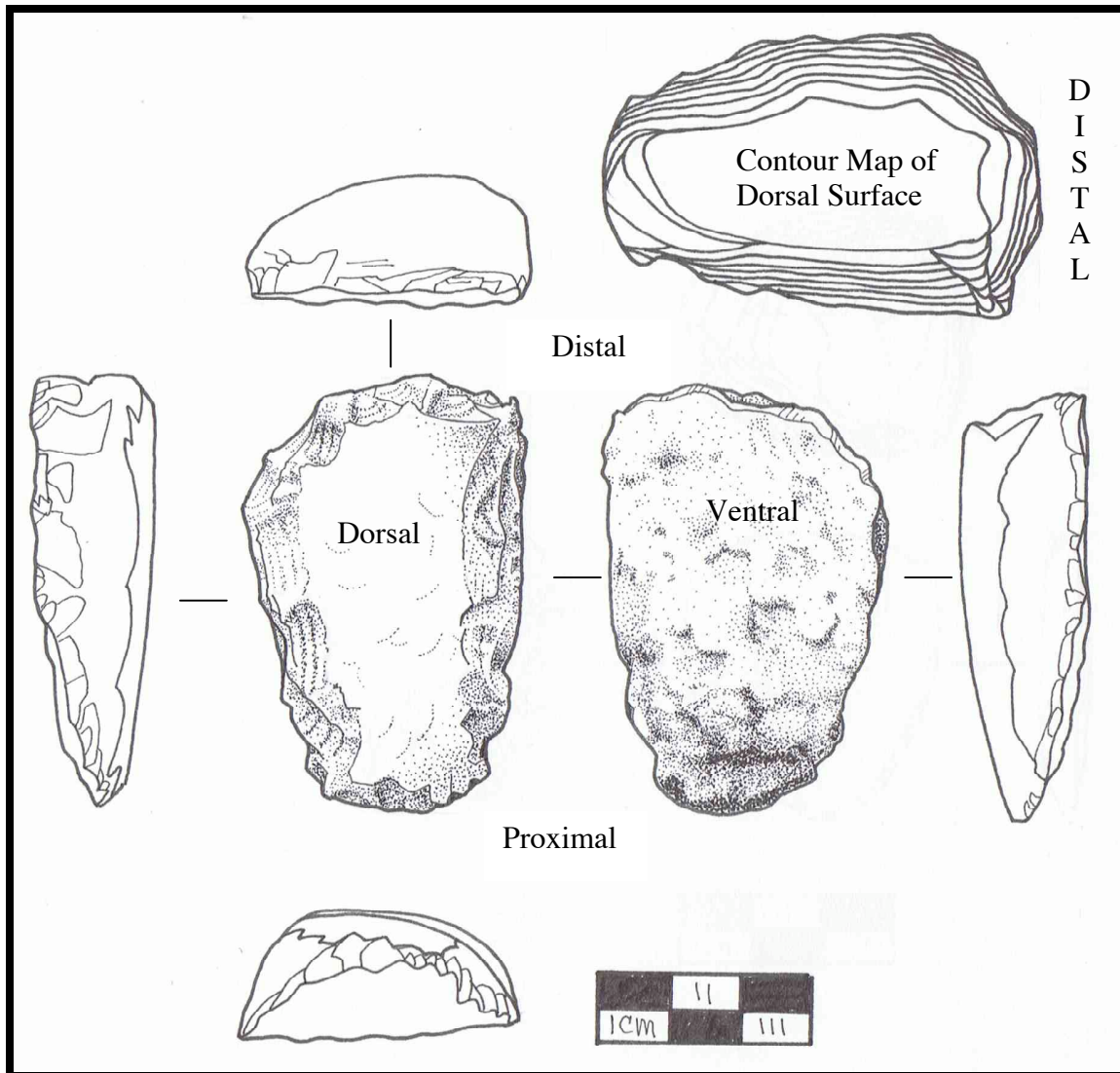


Figure 2.2 An endscraper from Saskatchewan surface collection. Cortex is located on the dorsal surface.

Naming

The name Eldon refers to the late Eldon Johnson who was an archaeologist in Saskatchewan. Johnson obtained his Master's degree at the University of Saskatchewan, his thesis defining the more common stone material types present at archaeological sites throughout Saskatchewan. He (1984; 1994) also discovered a large cache of Eldon uniface tools at the Aitkow-3 site on the southwestern shore of Lake Diefenbaker,

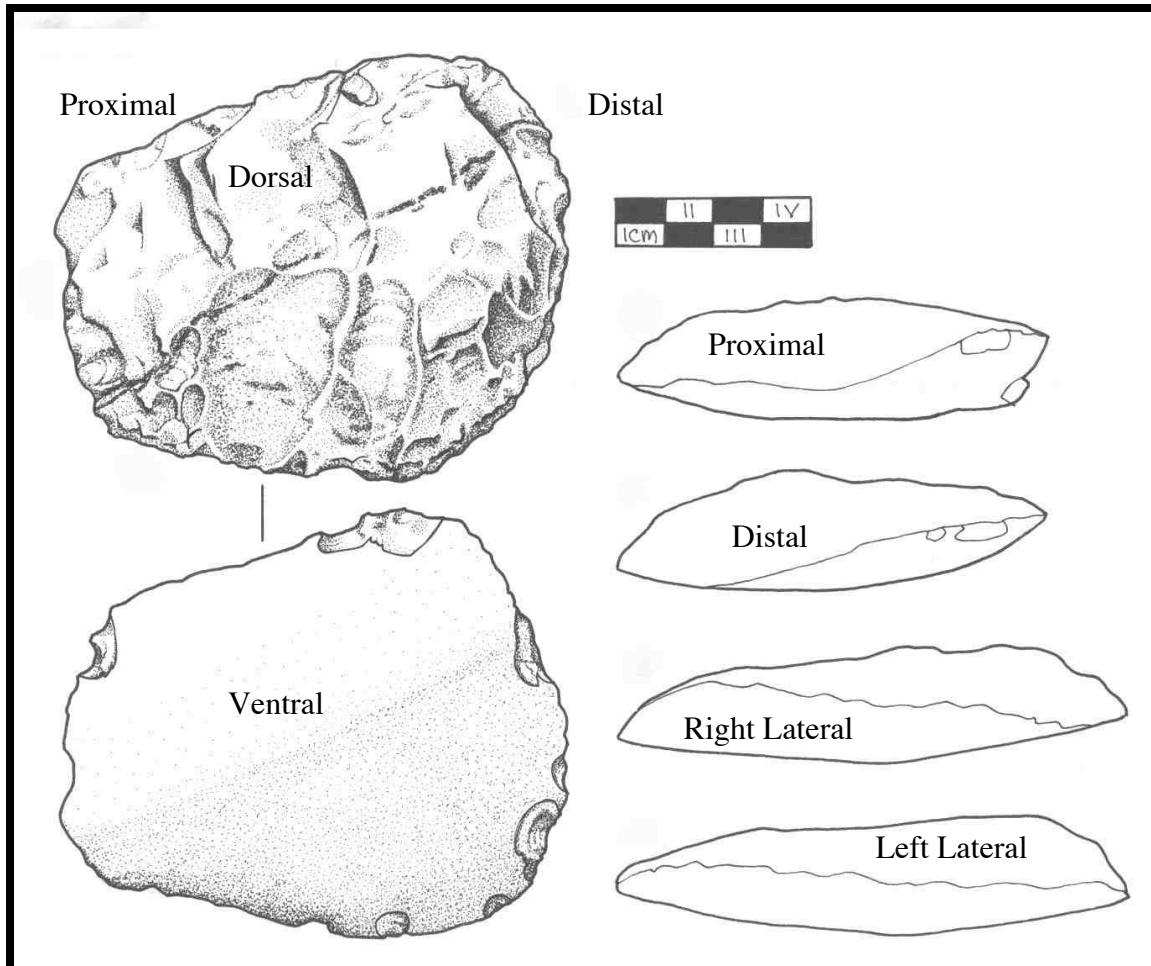


Figure 2.3 A Classic Eldon uniface with orientation labeled (from EgNp-63).
Cortex located on ventral surface.

Saskatchewan. This cache contributed substantially to this thesis and because of this it was believed appropriate to apply his name to these particular stone tools; however, Johnson (1984) called these tools 'choppers' when he found the Aitkow-3 site. It is advantageous to use his name to describe these tools because his name is unique in comparison to other named unifacial tools on the Canadian Plains. 'Eldon' also does not suggest a function, culture, or time period affiliation.

Eldon unifaces were previously coined '*reverse unifaces*' by Steven Kasstan (2004) based on his analysis of artifacts from the Below Forks site, Saskatchewan. Independently, Daniel Meyer of Lifeways Consulting, also used the term 'reverse' unifaces (personal communication 2009). It was not until Kasstan's presentation at the Plains Conference held in Edmonton in 2006 that the two researchers realized they were using the same name. Meyer and Kasstan used the term '*reverse*' in respect to the cortex being present on the opposite face than is normally found on a uniface. The term *Eldon* replaces '*reverse*' because of the term's vagueness. Prefixing the word 'reverse' before uniface is confusing. It is true that the orientation of the uniface is flipped, or reversed, but not the uniface itself. To say that a *uniface* is *reversed* suggests that the flaking pattern is reversed and not the orientation. Perhaps more appropriately the tool should have been called a '*reverse orientated uniface*', but this name is awkward and archaeologists usually prefer one or two word names for artifact types.

Another reason to replace the term 'reverse' is that Kasstan in fact *did not* have Eldon unifaces in his study. When researching this thesis the artifacts that Kasstan had studied were re-analyzed. Artifacts from Lake Diefenbaker and surface collections from Saskatchewan, and FgQf-16 and the HhOv sites in Alberta were all previously analyzed prior to assessing the Below Forks site. This previous study allowed for a group of traits to be noted in comparison to future artifacts that might also be Eldon unifaces. Upon initial investigation it became apparent that the Below Forks artifacts were instead a mix of utilized flakes and utilized split pebbles; this is again discussed in Chapter 5. This variability alone in the Below Forks artifacts would indicate problems in assigning them to the same tool category.

Other names have also been used to define these tools, such as gouge and planer (Walker 1992; Urve Linnamae personal communication 2008; Dan Meyer personal communication 2009; Ernest Walker personal communication 2009). The terms gouge and planer refer to kinds of stone tools that are used across the world during many different time period. These tools can take many different forms for these names refer to functions and not to a particular *style* or *design* of a stone tool. The late Richard S. McNeish proposed the term planer (Linnamae personal communication, 2008) based on his fieldwork in the American Southwest where he saw similarities in tool forms. In a

similar way, Walker (1992:49-53, 83-85) offered the term gouge because he saw morphological similarities between artifacts at the Gowen sites in Saskatoon and Clear Fork gouges from Texas. While both gouge and planer may be appropriate for these artifacts, neither term reflects the tool's morphological uniqueness nor reflects how they differ from other stone tools in the Canadian Plains and adjacent regions.

2.1 Eldon Uniface Types

The stone tool artifacts discussed here share similarities but also have differences that set them apart into four kinds. Figure 2.4 depicts the four kinds. This arrangement is viewed akin to Boast's (1997; Jones 2007:20, 124) fuzzy categories. Figure 2.4 begins with an unmodified flake that had been struck from a quartzite cobble, although it needs noting that some of the artifacts are made from other stone materials like siltstone. This upper box ties all the lower boxes together through a number of similar traits. This beginning is crucial for it further illustrates the first separation of unifaces. On one side of Figure 2.4 are the split pebble unifaces and on the other are Eldon unifaces, or flaked cobble spalls. Split pebble unifaces and Eldon unifaces are considered separate in this thesis, as the Eldon unifaces are the focus, but the artifacts are associated with one another at archaeological sites. They both have similar manufacturing steps such as bipolar flaking. In addition, other researchers have in the past grouped split pebble unifaces with Eldon unifaces (although at the time called 'reverse' unifaces) (eg. Kasstan 2004) and so there was a perceived need to draw a distinction between the two. They share the same traits that characterize the first box in Figure 2.4.

Before discussing the differences between split pebble unifaces and Eldon unifaces, the similarities need to be first described. First and foremost, these tools are made from naturally worn ovoid stones: Eldon unifaces from ovoid cobbles, split pebble tools from ovoid pebbles. Cobbles average 64-256 mm in size and pebbles are generally below 64 mm (Johnson 1991:79). Ovoid cobbles are found throughout the Canadian Plains (Johnson 1998). Both Eldon unifaces and split pebble tools also have one face covered entirely or nearly entirely in cortex. This is a rule with no exception. The third similarity is the unifacial flaking of the non-cortex face.

The process of creating Eldon unifaces is similar to that of split pebble unifaces except that the final edge modification is more intricate for Eldon unifaces. This process,

also called a sequence model, is more thoroughly described in Chapter 6. However, a rudimentary discussion will help explain differences between split pebbles and Eldon unifaces, and more broadly how these types are defined. The first step is to split a worn stone. The splitting of the stone is likely accomplished using a bipolar knapping technique. The flake removed from the core is then flaked in one direction on the non-cortex face. The shape of flake scars is informative in that their shapes are indicative of what type of hammer was used to remove the flake, the amount of force applied and other such factors (Whittaker 1994; Andrefsky 1998). For Eldon unifaces it appears that hard hammers and soft billets were the instruments of choice. These two basic steps are what characterize and string all of the below types together. Not only must these artifacts have the above-mentioned morphological traits, but they must also have these two basic manufacturing steps.

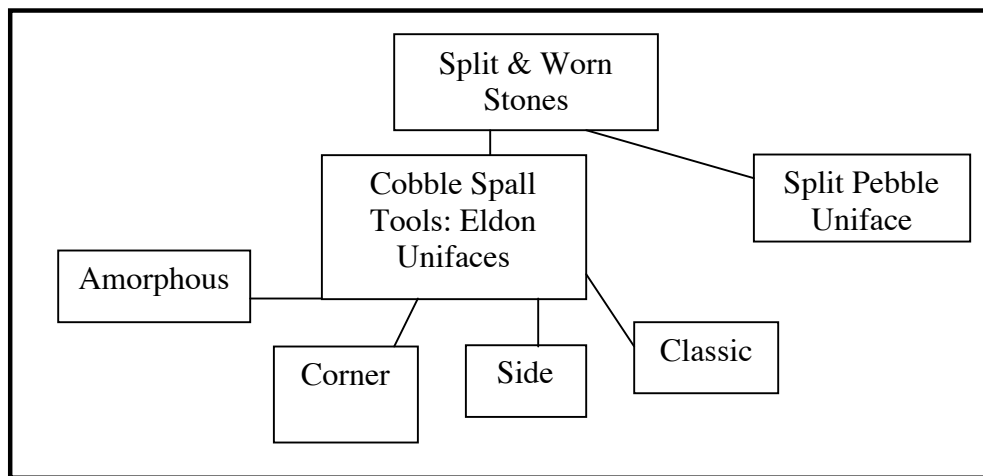


Figure 2.4 Arrangement of how the four Eldon unifaces are related, and also how they are related to utilized split pebbles.

When analyzing and characterizing these stone tools, a map begins to emerge as to how these tools can be understood. This map forms a small upside-down branching tree that is a product of the tool's heterogeneity. As stated above, the first main division is found in the split pebbles and cobble spalls. These two divisions are linked by the similar usage of ovoid stones and that one face of the tool is entirely covered in cortex. The shape of the initial cobble flake has implications for the shape of the Eldon uniface. Other studies have shown that a tool's preform shape can have repercussions on the tool's final form (Kuhn 1992a). Stout (2002:711) wrote that larger cores were commonly used by

skilled knappers and smaller cores by less skilled knappers. To a lesser extent, Dibble (1987) further discussed this issue. It is possible that the larger Eldon unifaces might be the product of more skilled flintknappers as argued by Stout (2002:710), and such size differences might conjointly result in slightly different overall morphologies that could be confused as representing new types. This was kept in mind while formulating the Eldon uniface types and is why uniface types from the Gowen site were identified as Eldon uniface types even though the Gowen specimens were the smallest of those in any of the assemblages.

While there are some similarities between pebble tools and Eldon uniface types, there are also a number of important differences. The primary difference is that split pebble uniface types are smaller than the average Eldon uniface. The first division between Eldon uniface types and split pebbles is listed as cobble spalls in Figure 2.4. Secondly, split pebbles are not always constructed from quartzite, which is the common lithic material for Eldon uniface types. This quartzite is fine to medium-grain Rocky Mountain quartzite, and less commonly Athabasca or an unknown variety of quartzite. Split pebbles are commonly made from fine-grain quartzite, chert, or silicified siltstone (an example of which is shown in Figure 2.5). A third difference is that cortex can be present on the dorsal and ventral surface of split pebbles. The dorsal face of a split pebble will sometimes have small patches of cortex remaining because when the pebble is bipolarly split, the pebble will flake on both faces of the pebble instead of splitting down the middle. Fourth, and perhaps most importantly, is that split pebble tools do not have the same extent of edge modification as flaked cobbles. Split pebbles will generally only have modification along the working edge, which is located on the distal or proximal edge.

Cobble spalls are large quartzite flakes removed from smooth and round (worn) cobbles. These flakes are removed through hard hammer bipolar percussion, which can result in some crushing on the striking platform or the opposing platform where the stone rested on the anvil. Due to the amount of force required to detach a spall, shattering of the striking platform can be common. The striking platforms tend to be located on the shoulder of the cobbles or where the cobble is most angled. The bipolar flintknapping of these cobbles can produce either flat-faced flakes or thicker and more curved flakes, which is likely a product of the angle at which the hard hammer made contact with the cobble and the nature of the quartzite material itself. The flake is further modified to

produce patterned edges and to thin the flake if necessary; split pebble tools are not thinned. This further modification produces heterogeneity in Eldon unifaces, as illustrated in Figure 2.4 with the branching lines from the cobble spall box.



Figure 2.5 Two unmodified split pebbles (artifacts provided by Karin Steuber). Left: dorsal surface, right: ventral surface.

All of the categories that spider from the flaked cobble box are forms of Eldon unifaces for they all share the same primary characteristics. One of the most important attributes is that all Eldon unifaces have one face covered in cortex. A second important attribute is that all Eldon unifaces are unifacially flaked. A third common trait is that all Eldon unifaces were made with the attempt to be thin. The word *attempt* is key, for while some pieces have been thinned through further flake removal, some have remained thick but step terminated flake scars encompass these thick areas. Step terminated flake scars result from the force of the flake removal stopping prematurely (Whittaker 1994), likely because the force of striking a quartzite stone does not move through the material as evenly or smoothly as it does in finer-grained materials like chert and obsidian. If the flakes had continued, they would have extended towards the piece's midline. Failed or step flake removals produce a thick central region on an Eldon uniface with step terminations encircling it. Fourth, and differing from split pebbles, is that most are made

from fine to medium-grain quartzite stone or to a much lesser extent other fine-grain stone like siltstone. Lastly, Eldon unifaces are usually made from ovoid quartzite cobbles that are the size of an adult's fist or bigger, except at the Gowen site, which utilized much smaller cobbles. It appears that much like the use of quartzite, the large size of Eldon unifaces was a preference and not a rule.

2.1.1 Classic

Classic Eldon unifaces are the most numerous of the four types and were the style originally discussed in the few sources that referenced these tool forms specifically (eg. Johnson 1994) hence the name Classic. There are 88 artifacts in this sample. This category is easily differentiated from the other categories for it is characterized by only one distal or working edge, has slightly rounded corners and commonly a convex distal edge (Figure 2.6: A (top) shows an Eldon uniface that has considerable edge modification along both lateral edges that produced a noticeably tapered proximal region. B (bottom) likewise has lateral edge modification, but to a much smaller degree. This edge modification did not result in a tapering of the sides for this was already naturally present, but rather produced a thinning of the lateral edges also like that seen in A). These stone tools furthermore tend to be larger than the other categories and commonly have an ovoid shape. These 88 artifacts have an average weight of 87.9gm, length of 6.3cm, width of 2.9cm, and a thickness of 1.7cm. They commonly have the striking platform opposite to the working edge. Evidence for these platforms is commonly a crushed portion of the proximal edge along the cortex of the ventral face, a remnant bulb of percussion on the dorsal face, occasional evidence for shattering around the striking platform, and the rare presence of lines of percussion on the dorsal face.

There are two issues with identifying the striking platforms. One relates to the fact that these tools are made on large flakes produced through a bipolar method, and so there should be two striking platforms (Berman et al. 1999): one where the cobble rested on the anvil and the second where the hammer struck the cobble. These platforms are virtually identical to one another except the platforms tend to be larger and more pronounced

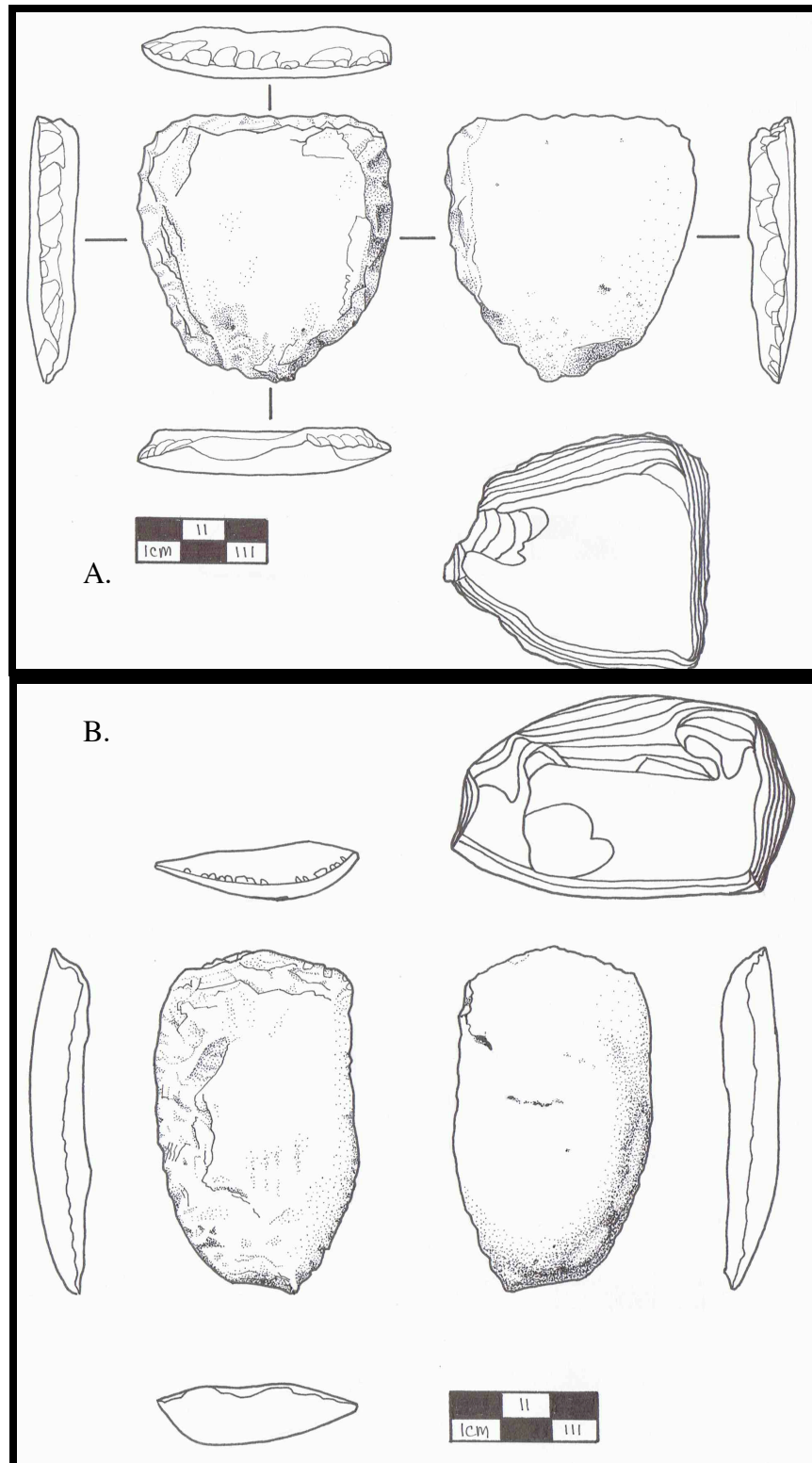


Figure 2.6 Two Classic Eldon unifaces (top: EgNp-63, bottom: Saskatchewan surface collection).

where the hammer struck the core. Because both platforms are similar, it is difficult to determine whether the observed platforms have been produced by the hammer or the anvil, especially since one has been heavily modified to produce the working edge. The second issue is that the platforms are not always present since some Eldon unifaces have edge modification that wraps around the entire tool. Some of this edge modification likely relates to how the tool was hafted and will be discussed in a later section.

The number of modified edges varies for Classic Eldon unifaces. Some of the unifaces have edge modification only on the working (distal) edge. Other pieces have modification along the distal and one or both lateral edges, while a third group has modification along all the edges. This modification is similar in that the flake scars are of a similar size with a common strategy of producing lateral edges that gently taper to the proximal region. This is done by removing thinner and longer flakes that reach farther across the dorsal face of the piece to make it thinner. The tools that have edge modification along only the distal edge commonly have lateral and proximal edge shapes and overall thinness that, without modification are similar to those of the shaped tools. In other words, if a piece is naturally thin with lateral edges that taper to the proximal region then there is little further edge modification except at the distal edge.

2.1.2 Corner

Corner Eldon unifaces are the second major category not because of their number but because of their homogeneity. This category is represented by nine artifacts and has the least amount of variability in comparison to other categories. A typical example from this category is presented in Figure 2.7 (left lateral edge is facing up). These tools have an average weight of 41.6gm, length of 2.2cm, width of 2.2cm, and a thickness of 1.4cm. The similarity of the length and width measurements reflects the tool's square to rectangular shape.

Corner Eldon have corners near 90° (hence their name) and striking platforms are always present on a lateral edge, usually the right lateral. This platform is located on a flat portion of the ventral face that sharply curves towards the dorsal surface. An unusual specimen comes from the Gowen site, where all four sides were flaked, but the rectangular outline remained and one edge was more heavily worn than the others,

indicating it was the distal edge (as shown in Figure 2.8); on the ventral surface the heavily worn distal edge was flattened and deeply striated as depicted in the illustration.

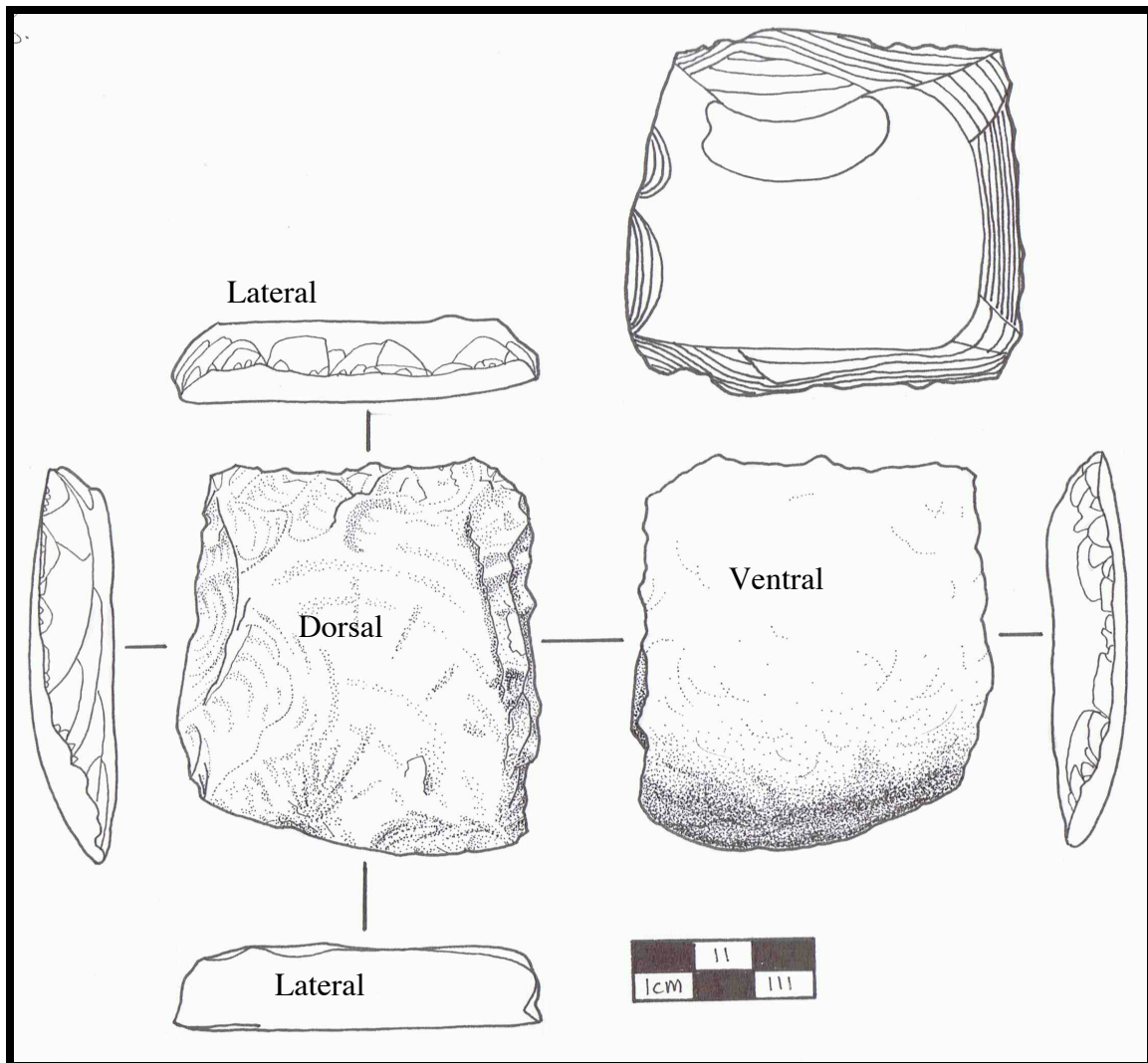


Figure 2.7 Corner Eldon Uniface with the square shape (EgNp-63).

Dorsal surfaces are flat with no thinning flake scars as the preform flakes are naturally thin. The opposite edge of the striking platform is sometimes flaked, producing a shallow angle as shown in Figure 2.7; when this edge is not flaked it still has a shallow angle. The proximal and distal edges are both flaked. Commonly, both edges show signs of wear, although, as explained in Chapter 6 one edge may have been used to process a material while the other accrued wear from hafting.

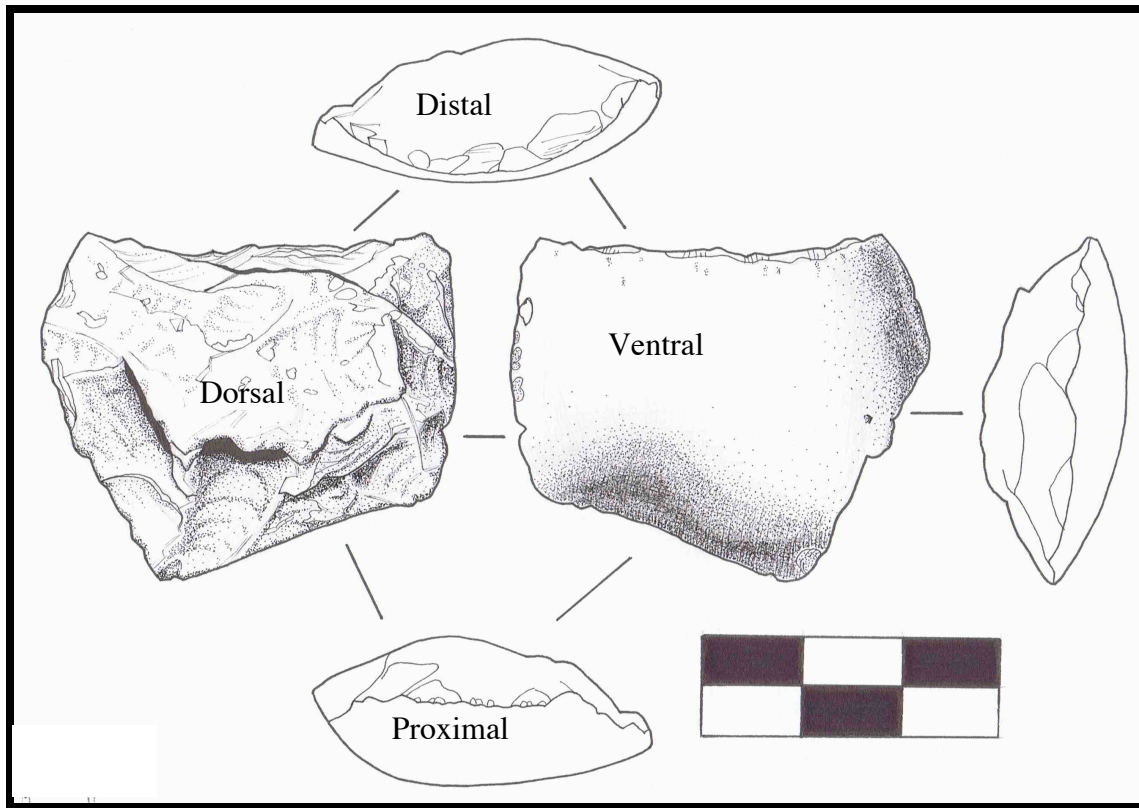


Figure 2.8 An irregular-rectangular shaped Corner Eldon Uniface with all four edges flaked (Gowen site).

2.1.3 Side

The third category is defined by modification restricted to only one edge of the tool, which is additionally the longest edge of the stone tool (Figure 2.9). There are four known examples of *Side Eldon unifaces*. These tools would commonly be called side scrapers but for the presence of cortex along the ventral surfaces, their enormous size, and that a bipolar technology was used to remove the flake from the original cobble core. This category is smaller than the above second category, and like the second category does not have a large degree of variability. The decrease in variability is likely a result of the small sample size.

Edge modification is present on the Side Eldon uniface's longest edge. Their outlines tend to be ovoid. These artifacts have an average weight of 111.5 gm, length of 6.8cm, width of 6.2cm, and a thickness of 1.7cm. Striking platforms are commonly retained but their location in relation to the working edge is variable. There is no evidence to indicate hafting, as edge modification is restricted to the working edge; there

is no tapering or thinning of the pieces. Of the four examples, three have shallow edge angles and the fourth is steeper.

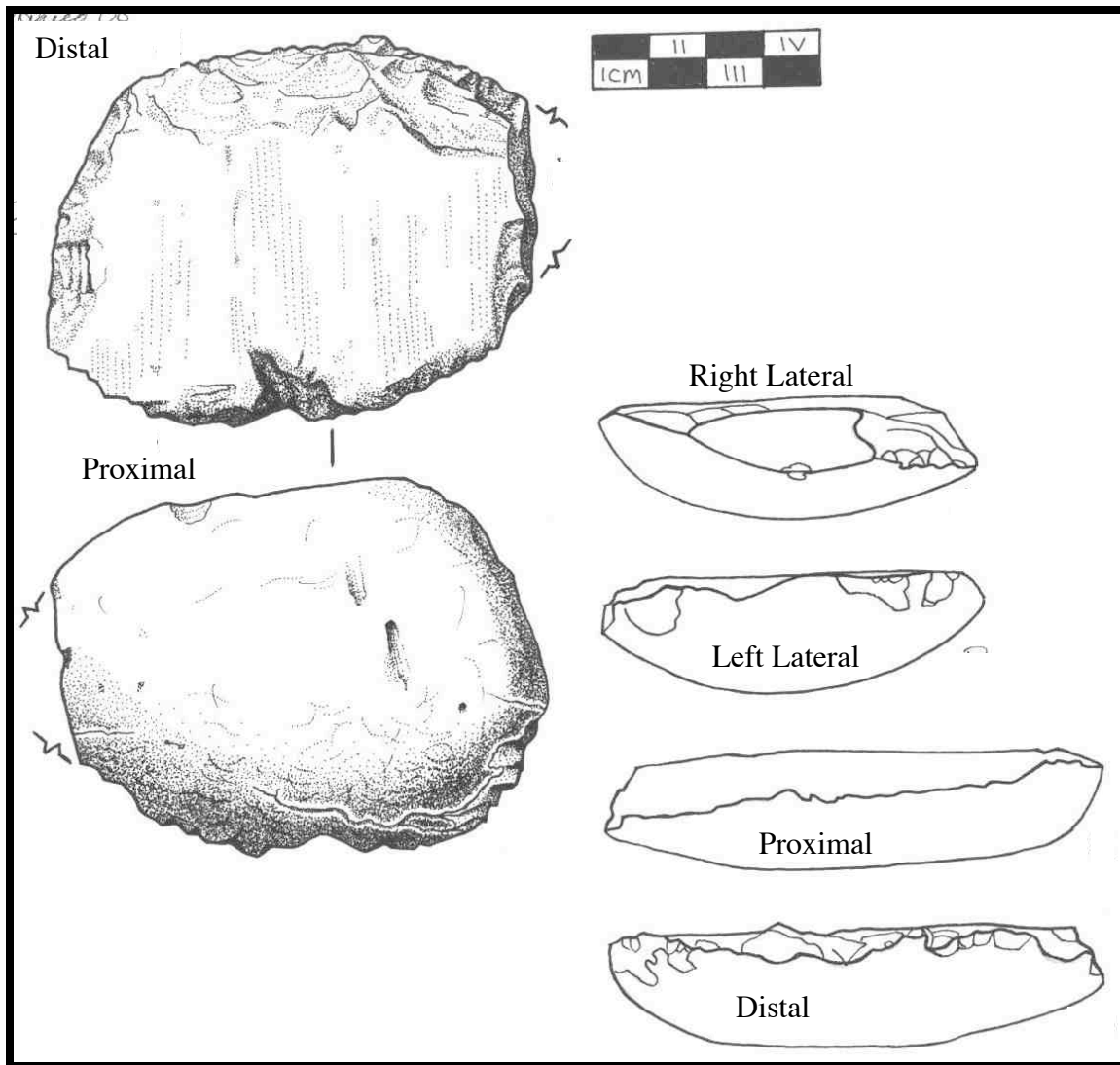


Figure 2.9 Side Eldon uniface (Alberta surface find).

2.1.4 Amorphous

Amorphous Eldon unifaces are the final type. This category is aptly called amorphous for its high variability in comparison to the other types. There are 10 examples of this type. Substantial edge modification producing two or more working edges is the backbone to this type. Edge modification also continues around the circumference of the tools. It is unclear if this was to aid in hafting or handling.

There are no discernable proximal or distal edges with the multiple working edges. Lack of a clear distal or proximal edge also prompted the designation as amorphous. Outlines are grossly spherical. The average weight is 55.6gm, length 5.4cm, width 2.5cm, and thickness 1.7cm. The dorsal outline appears more irregular than the ventral face, as suggested in Figure 2.10. Edges tend to be irregular with some almost serrated. They are moreover relatively thin, a mixed product of the original preform's shape and a conscious effort to thin the piece.

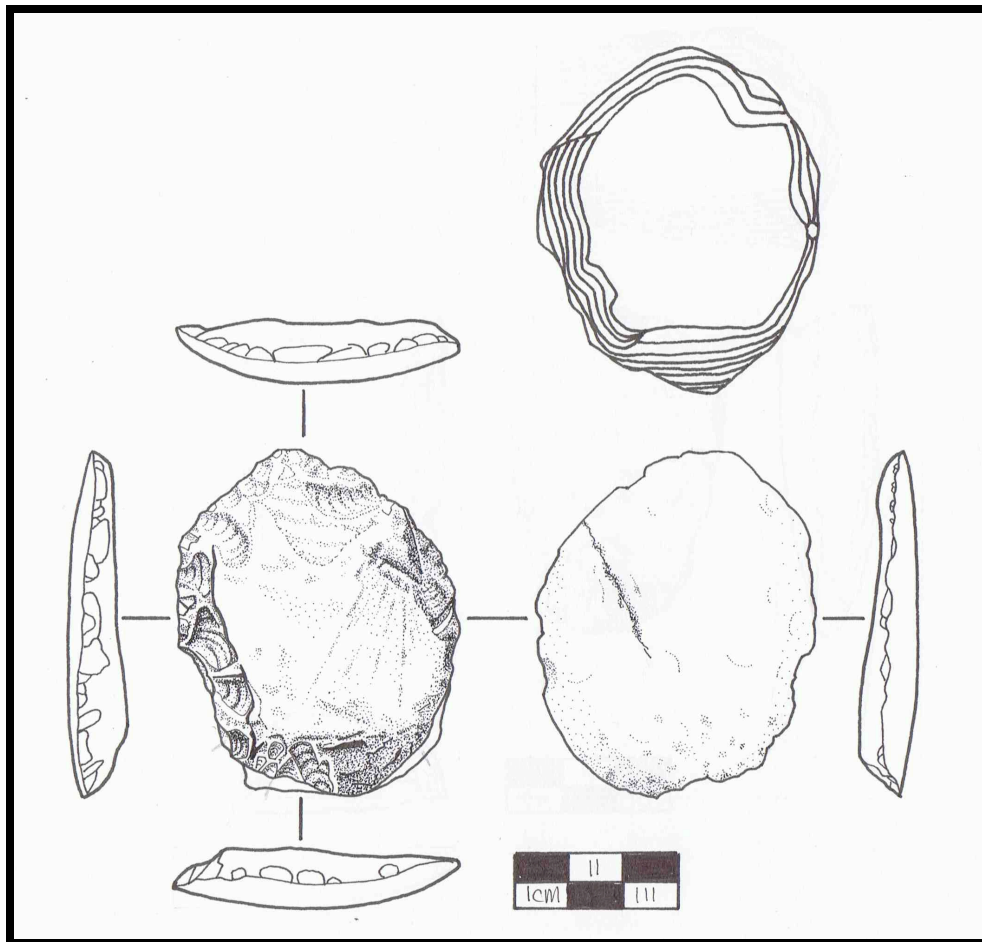


Figure 2.10 Amorphous Eldon uniface (Saskatchewan surface collection).

2.2 Discussion

Separately, Schlebecker (1982) and Tilley (2004) proposed the idea that objects need to be held, manipulated, and ultimately experienced for the researcher to fully appreciate and understand the materials they are studying as opposed to just reading about or looking at them from various media images such as photographs, illustrations, basic

written or verbal descriptions. This is because there are a litany of differences between the second and first hand experiences such as the balance of an object that can only be measured and felt through the muscles of the body and not of the mind. This experience leads to how information can be communicated. Information is incomplete when an object is only quickly or partially witnessed, or known through second hand information. This, for pre-contact archaeology purposes would recommend that the transmission of ideas is most securely and completely accomplished when an object is interacted with in a first hand manner. Although, as Schlebecker points out, memory is not a steel trap. Schlebecker (1982:112) quoted Dylan Thomas who wrote that “I can never remember whether it snowed for six days and six nights when I was twelve or whether it snowed for twelve days and twelve nights when I was six”. For the transmission of ideas, and even retention of ideas, their degradation does not mean that the entirety of the idea is lost, but rather altered with the retention of the core principle. For Thomas, this means that the principle of snowing at an early age remained but not the exact detail of when and how long. For stone tool technologies this suggests that variability in form can and should occur over time, space, and populations. The form will change as ideas are shared amongst groups and perhaps within groups, as a tool may only be used once a year or at even longer intervals. Perhaps, too, variations will take place as people move about the landscape as the Pre-contact aboriginal groups of the Canadian Plains assuredly did. This movement involved a separation from place, where each place likely had a different meaning and different associated actions. If so, then ideas may change through both space and place when people adhere to this form of cultural and perhaps logistical strategy. It needs emphasizing that throughout all of this variation and alterations in time and place culture remains constant. Cultures can change without losing their identities and this should be true for their material products as well.

Variation in Eldon unifaces may then be a product of displacement and memory loss. The basic tenets of the idea behind Eldon unifaces remained intact as the memory of their purpose stayed constant but not the details of their exact form. The large geographical spread of these tools would support such an argument since there are differences between groups of artifacts at each site. The differences observed within individual site assemblages are smaller than those at multiple sites. This intra-site

variance might then be a product of a separation in time, where ideas are altered as people left an area and then returned at a later date, such as would be indicated with the Aitkow-3 site. Variations at other sites such as Gowen could be the result of another source such as differences between individual knappers.

Cortex that covers the entirety of one face is an important attribute that links all of these artifacts together. This singular attribute is striking but it should not be viewed as the only significant attribute. The patterning and positioning of edge modification is also unique, especially in the case of the Corner Eldon unifaces. The curvature of the mouths is another unique feature as is the dominance of quartzite materials. These and other attributes combined make these tools unique in Saskatchewan and Alberta, and supports their separation and inclusion in the above typology. Future studies must consider this suite of attributes when classing newly found artifacts. However, it must also be remembered that the sample size is relatively small and new variations will likely be discovered. These new variations should then be added to the already listed suite of attributes, enlarging the typology's shadow.

2.3 Conclusion

This chapter proposes four types of Eldon unifaces: Classic, Corner, Side, and Amorphous. The name Eldon replaces previous terms and the artifacts themselves are formed tools. Related to the four types are split pebble tools. There are four main differences and three similarities between split pebble unifaces and Eldon unifaces. The similarities are found in the usage of smooth cobbles, the retention of cortex on one face, and the unifacial flaking. On the other hand, split pebble unifaces are smaller than flaked cobbles, are made from a variety of different lithic materials, cortex can sometimes be present on dorsal and ventral faces, and they have less edge modification than Eldon unifaces.

Chapter 3

Context

History is not just created by people but is also something that creates persons.
Jones 2007:67

3.0 Introduction

Eldon unifaces are known only from Middle Period archaeological sites from the Canadian Plains of Alberta and Saskatchewan and the boreal forest of Alberta, but have similarities to artifacts from British Columbia, Manitoba, and the Eastern Woodlands /Maritimes. The first part of this chapter addresses the role of stone tool artifacts during the early-Middle Period on the Northern Plains. Brief characterizations of the climate and subsistence focuses are also presented.

There are only a few associated dates with the Eldon unifaces discussed in this thesis, but those dates all fall in the early-Middle Period. The sites Eldon unifaces are found at are discussed following the early-Middle Period overview. A commonality in these sites is that they were all habitation sites. Sites with likely Eldon unifaces encountered during the thesis research but not physically analyzed are also mentioned. Not all of these artifacts were obtained for study.

A survey of unifacial stone tools from British Columbia, Manitoba, and the Eastern Woodlands /Maritimes is the final component of this chapter. Much of this survey focused on the early-Middle Period. British Columbia had the strongest similarities in with the cobble spall tool artifacts. These tools share multiple morphological similarities and likenesses in the types of sites that they are found at. It is argued that these tools and Eldon unifaces represent a similar technological *adaptation* to a particular *problem*, and a possible cultural connection.

3.1 Middle Period

This section presents a short overview of the Middle Period on the Northern Plains. Eldon unifaces date to this period and hence context is added to these artifacts with a brief discussion of the climate, subsistence focus, habitation strategies, and technology of the period. The climate is described for both modern and early-Middle Period values to provide an indication of how much it has changed. It is recognized that there might be

precursor forms of Eldon unifaces in the preceding Plano period, but such a discussion would go past the scope of this project. Further, while the technology and form of Eldon unifaces were new to the Middle Period the task in which they were employed may have not been. Studying artifacts in such a contextual light is reminiscent of what Jones (2007:46) wrote, in that “material culture is critical to the maintenance and performance of tradition”. This tradition can last longer than the technology itself, and Jones (2007:43) further wrote that: “it is not necessarily true that descriptions of memory irrevocably change with the utilization of fresh technologies, rather, new technological products provide us with fresh metaphorical perspectives on memory”.

The Middle Period encompasses, in succeeding order: Mummy Cave Series (7,500-6,000 BP), Oxbow complex (6,000-5,000 BP), McKean Series (5,000-4,000 BP), Pelican Lake (4,000-3,000 BP), and Besant (3,000-2,000 BP) (Frison 1998; Wright 2006:131, 291; Meyer and Russell 2007:106). There are many instances in the archaeological record where these dates overlap and not all archaeologists agree to the precise nature of these dates. Some moreover discuss the Mummy Cave Series separately from the Middle Period (eg. Wright 2006). The Middle Period is also called the Archaic Period or Mesoindian period (Forbis 1992; Frison 1998). This thesis is not concerned with the organization of Northern Plains chronology and left the arrangement as is and unquestioned. Further, as the interest was primarily on the early-Middle Period and Mummy Cave Series, the succeeding Oxbow complex is only briefly discussed in relation to the Mummy Cave Series when it demonstrates a shift in technologies. The succeeding groups /periods are not discussed at all.

Climate

The climate during the early-Middle Period was significantly different from modern values. During this period aridity and warmth characterized the climate (Yansa 1998, 2007). In the 1940's Antevs dubbed this climatic episode the Altithermal and others have referred to it as the Hypsithermal (Frison 1975:294, 1998:160; Dixon 1999:238). It lasted for much of the early-Middle Period, between 9,000 to 6,000 BP following the Neoglacial glacial advancement (Beaudoin 2003:11). This alteration in climate influenced changes in vegetation (Meyer and Russell 2007:106), which in turn impacted

the lives and cultures of groups residing on the Northern Plains (Forbis 1992). For instance, the grasslands of the Canadian Plains spread northwards (Ritchie 1976). However, these changes were not the same everywhere (Schweger 1987; Sauchyn and Sauchyn 1991).

Despite this period's altered climate, aboriginal groups never left the Northern Plains (Vance et al. 1995). Instead, different strategies were implemented to cope with these changes. People adapted to the changing climate by living closer to reliable water sources such as the Saskatchewan River (Winham et al. 1996:18). The archaeological result of living close to water sources was that early-Middle Period sites are likely deeply buried in alluvial sediment and hence more difficult to discover (Winham et al. 1996:18).

Subsistence

The subsistence economy during the early-Middle period focused on an extinct form of bison (*Bison occidentalis*) (Forbis 1992). These animals were caught with the use of bison jumps and communal hunts (Frison 1998:161). Additional food sources included dogs, birds, pronghorn antelope, and other small animal species (Frison 1972, 1998). These secondary food sources might represent diversification encouraged by a deteriorating climate.

Fish too may have played a role in subsistence regimes, but this is difficult to prove for at least three reasons. One is that fish remains do not always preserve. Second, screen mesh sizes used at site excavations are commonly too large to catch the smaller fish bones (Reid 1988). Third, larger fish remains (heads) may have been fed to dogs, much like what occurred in British Columbia (Rousseau 2004:25).

The Gowen 1 site is rare for it has evidence of burnt plant remains (Walker 1992). Evidence from the Pryor Mountains of Wyoming at this time, yet, suggested an increase in plant food consumption (Winham et al. 1996:18), but this might apply only to the upland areas in the Plains. In this region, sandstone manos were used to grind plant foods. Such manos are likewise known but rare in the Northern Plains (Frison 1973:305; Webster 2009:65).

Technology

There are a number of different diagnostic points that date to solely the early-Middle Period. These points differ from earlier forms in that they have side-notches (Winham et al. 1996:18; Kooyman 2000:119). The points were likely used to tip dart points used in atlatls. Some of the point styles occurred at the same time but in different geographical regions. For instance, Bitterroot points are found in Alberta and Gowen points are found in Saskatchewan, but both date to the same time period (Frison 1972; Walker 1992:44; Kooyman 2000:119), and there are Mount Albion corner-notched, Blackwater side-notched, and Hawken side-notched from the U.S.A (Frison 1998:161).

While there were numerous changes in projectile point forms throughout Canadian Plains prehistory, there was somewhat less change through time for other artifact forms except for a general trend of decreasing size, general increase in numbers found, and the appearance of some new artifact types (Driver 1993). Some Palaeoindian tools continued for a short time in the Middle Period. On the Great Plains, grinding tools such as sandstone-slab metates and manos, and stone-filled roasting pits were carry-overs from the Late Palaeoindian period and their usages intensified during the Middle and later periods (Frison 1998:151; Webster 2009:65). Gravers and spurred endscrapers were also carry-overs from the previous period. Another continuation from the Palaeoindian period was that of stone tool caching. This is a common strategy for mobile groups as it reduces the weight of how much a group needs to carry (Kuhn 1992b; Odell 1994).

Lithic materials used to construct tools differed over time. Generally, much of the lithic material used by early-Middle Period groups was of local origin such as quartzite or mudstone (Driver 1993; Kulle 1996, 1997; Unfreed 1997), but a limited amount of non-local materials like Knife River Flint (KRF) from North Dakota was also used (Steuber 2008).

Early-Middle Period stone tool assemblages were “dominated by chipped stone tools” (Wright 2006:132). There are a number of different types of unifaces known from the early-Middle Period. End and side scrapers are common in Middle Period sites, much like Plano and Late Period archaeological sites (Fedirchuk 1987:23; Fedirchuk et al. 1998). Lateral unifaces and split pebble unifaces are also common (Fedirchuk 1987:106). Cobble tools are also prevalent during this period (Conaty 1977; McCullough 1981).

These tools are similar to Eldon unifaces in that these are used flake spalls derived from cobbles. Cortex remained along one face but no edge modification other than retouch of the edges occurred. The use of cobble tools continued in Oxbow assemblages but is poorly defined. Other flaked stone tools that characterize Mummy Cave assemblages are bifacial drills, chopping tools, hammerstones, pieces esquillees, and large bifaces including side-notched knives.

3.2 Site Context: Plains

Below are brief descriptions of the archaeological sites that the Eldon uniface samples came from or sites with likely Eldon unifaces that were encountered during this research. While only Saskatchewan and Alberta sites are considered, it is likely that these artifacts are found in the United States, in particular Idaho, Montana, and the Dakotas. However, this thesis' research was focused on the Canadian Plains and not the United States.

3.2.1 Saskatchewan Samples Context

Johnson (1998) proposed from personal observation that natural quartzite sources are uncommon in west-central and central Saskatchewan and “are apparently absent from most of eastern Saskatchewan” (1998:9). This may explain the absence of Eldon unifaces in eastern Saskatchewan and, in particular, Manitoba. All of the materials from the below mentioned sites come from the southwestern Saskatchewan region (Figure 3.1); this map also depicts the Stampede site (DjOn-26) in the Alberta Cypress Hills. All of these sites are located near the South Saskatchewan River (light blue line in Figure 3.1) and what has recently become Lake Diefenbaker (dark blue area in Figure 3.1).

Below Forks site (FhNg-25)

This site is situated below the confluence of the South and North Saskatchewan Rivers. In the eastern part of the site, three occupations were noted, the earliest being Mummy Cave (Kasstan 2004). Lithic raw material was predominantly of local origin, with quartzite the second most common material. Bipolar techniques were also evident. The site was likely inhabited during the late-winter to early-summer months. The faunal materials were from a number of different animal species.

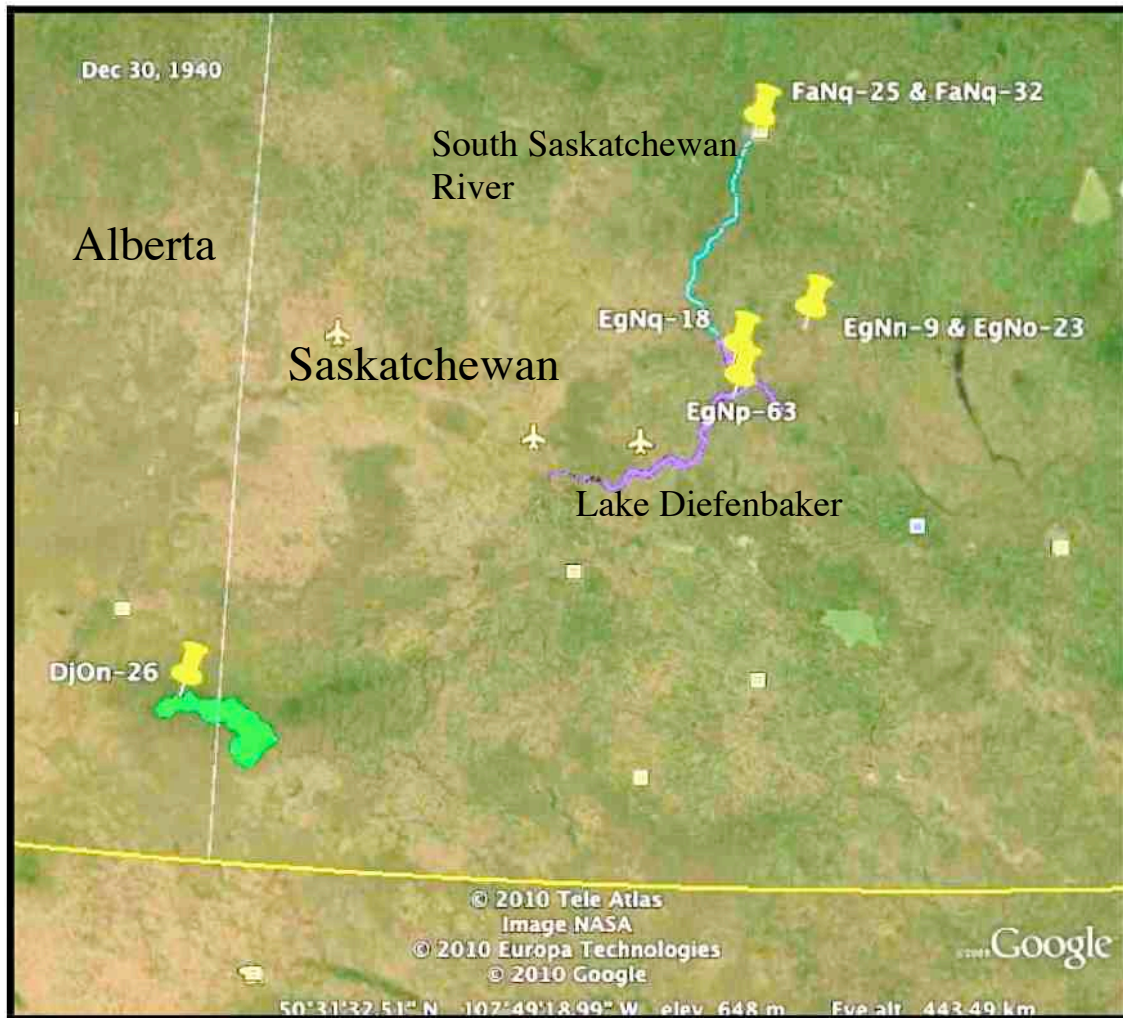


Figure 3.1 Location of sites with Eldon unifaces (Google Earth 5).

Four artifacts from the Below Forks site were originally labeled ‘reverse’ unifaces because of the retention of cortex on one face of the artifacts (Kasstan 2004:108-109); these four are shown in Figure 3.2. Comparison of these with other artifacts (from sites below) during my research has led to the conclusion that these are not Eldon unifaces. The Below Forks’ artifacts are much smaller and more importantly do not have the same formed, patterned, or substantial edge modification as that found on Eldon unifaces from other sites discussed below. Some also have cortex on both faces, indicating a different style of flintknapping. The artifacts are likewise made from cherts and quartzites, specifically Swan River chert, unlike most of the other collections discussed here. It is

argued that these are a collection of different tool forms: three split /modified pebble tools (Figure 5.2, A-C) and one modified flake tool (Figure 3.2, D).

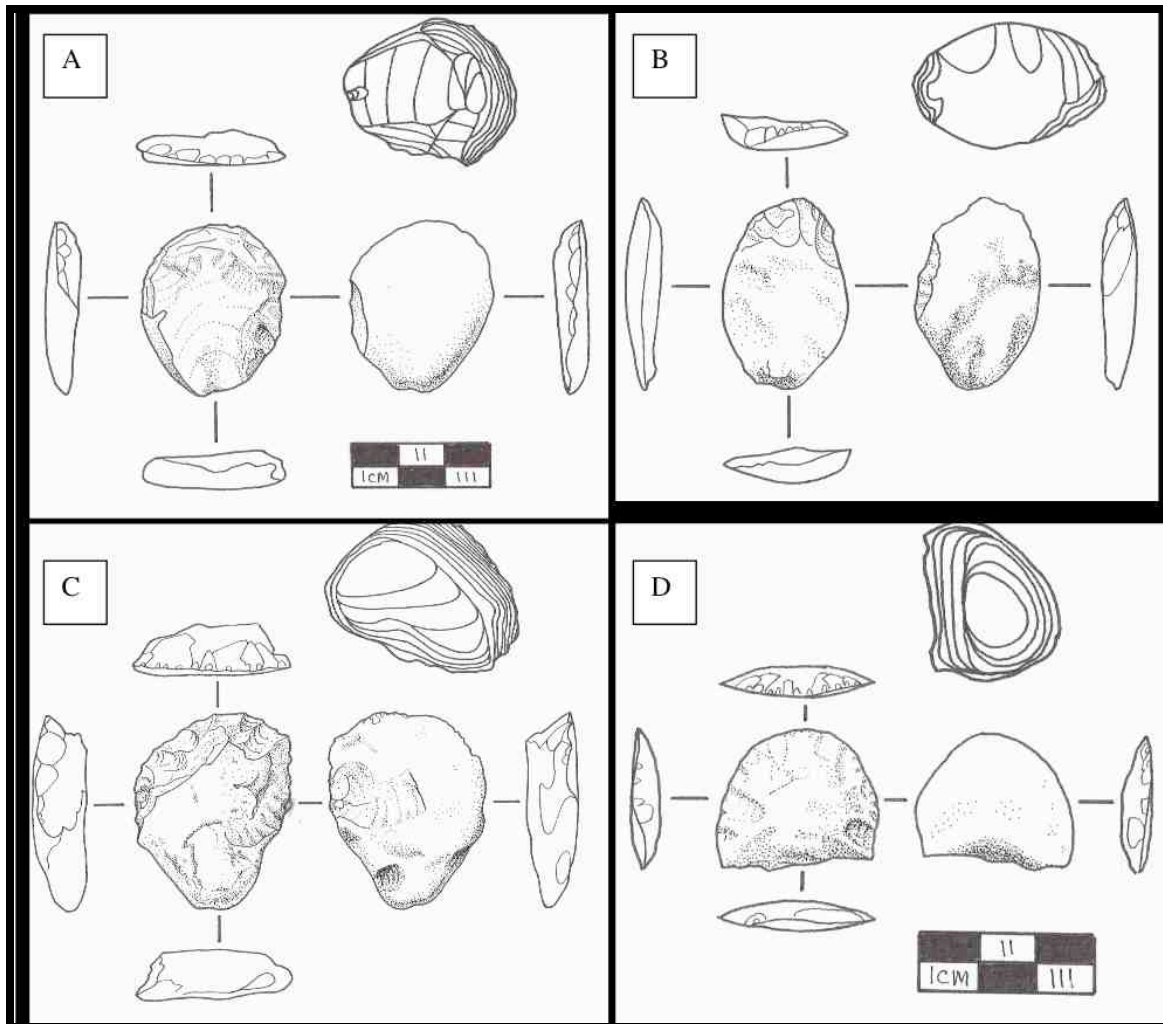


Figure 3.2 Artifacts from the Below Forks site, Saskatchewan. Ventral surface depicted on the center right, and dorsal on center left.

Dog Child site (FbNp-24)

The Dog Child site is located in Wanuskewin Heritage Park, just outside of Saskatoon (Cyr 2006). This is a well-researched site with few flaked stone tools, but includes one ‘reverse uniface’ from level 3b (Cyr 2006:120). Cyr (2006:120) described ‘reverse unifaces’ as

“...a large, quartzite [tool]...flaked from a primary decortication flake. This morphological style has been associated primarily but not exclusively with Mummy Cave occupations. Similar items have been recovered from the

Gowen sites, the Below Forks site, and other Middle Period occupations.”
(Cyr 2006:120).

Upon further investigation it was found that this was not a ‘reverse uniface’. Instead, this was a large domed scraper as it was especially thick, made from quartzite, had a very steep edge angle, and the ventral face did not retain any cortex. In Figure 3.3, the large white patch on the dorsal surface is calcium build-up.

The Dog Child site is important to consider for it is coeval and in close proximity with the Gowen sites that do have a number of Eldon unifaces (discussed below). The tasks, nature, and environment of the two sites are similar and yet curiously, Eldon unifaces are not present at both sites. As the Mummy Cave components are thoroughly excavated, with Opimihaw creek to one side, a slope to the other, and the components dissipating in the other two directions (Talina Cyr, personal communication 2010), it is unlikely that Eldon unifaces were missed during excavation.

Lake Diefenbaker sites (EgNp-63 & EgNq-18)

(EgNp-63: N=39, Classic=34, Angled=2, Amorphous=2, Side=1)

(EgNq-18: N=131, Classic=66, Angled=13, Amorphous=16, Side=1, Other=34)

In 1984, Eldon Johnson (1984 and 1994:80) recovered a large collection of Eldon unifaces from the Aitkow 3 site (EgNp-63). This collection, termed a cache, was located



Figure 3.3 Domed scraper from the Dog Child site. Both images are of the same artifact: on the right is the flat ventral surface, left is the flaked dorsal surface.

on an upland above the Aitkow Creek which has since become the Gordon McKenzie Arm of Lake Diefenbaker; on the eastern shoreline of Lake Diefenbaker. The area was heavily eroded from wind and water forces and was likely impacted sometime ago by a now abandoned CN railway line (Johnson 1994). The cache was part of a larger site with an artifact scatter over an exposed surface and a buried component that was left undisturbed; however, partially buried bison bone, lithic debitage, and FBR was observed. The scatter was grouped as one site, EgNp-63. Besant points had been recovered in the area but were not in association with the cache. In addition, 4 early side-notched, 3 Oxbow, 2 Pelican Lake, 4 late side-notched, and 10 unknown point styles were also found in the same area (Johnson 1984). Johnson (1994:82) again pointed out that Besant groups did not use quartzite to a significant degree and that this cache was likely not related to the Besant culture.

The cache contained 34 quartzite artifacts concentrated in a 2 square meter section of the 900m by 300m site (Johnson 1994:81). Eldon unifaces from EgNp-63 are shown in Figure 3.4. An additional 9 artifacts were found in a further 10-meter radius from the cache. These 9 artifacts were reportedly similar to the other 34. Johnson (1994:81) wrote that the artifacts were made from Rocky Mountain quartzite that had “fractured rather roughly with many step fractures”. Except for two of the artifacts, all had unifacially worked edges where one face retained 100% of the cortex. Johnson (1994:82) moreover argued that the artifacts were used to work hides since “the smooth cortex would be in contact with the hide and the sharp edge of the tool could be made to remove material from it”.

Upon reviewing this collection, the artifacts have been identified from Athabasca and Rocky Mountain quartzite cobbles, although Johnson (1994:81) wrote that the artifacts were all made from Rocky Mountain quartzite. The artifacts, most of which were covered in calcium carbonate build-up, had been stored in a box with little associated information save for a card with the following written on it: “This cache of uniface artifacts was found on EgNp-63 on the west shore of Lake Diefenbaker. Eldon Johnson”. A discrepancy is that a sticker on one of the artifacts lists a date of October 14th, 1977, which is 7 years prior to that which Johnson (1984; 1994:80) indicated as the cache found

date. Also, it should be noted that 42 artifacts were found in the box, whereas Johnson (1994:81) listed a total of 43.



Figure 3.4 Classic Eldon uniface from EgNp-63.

A further collection, originally listed as gouges, was also recorded from this area (Stevenson 1992, 1993, and 1998). EgNq-18 is situated along the current east shore of Lake Diefenbaker in close proximity to EgNp-63. The site was disturbed by fluvially deposited mud and silt during the previous spring melt. All but one of the artifacts was made from quartzite. This was instead made from feldspathic siltstone. Similarities in the artifacts were listed as

“constructed from a large primary decortication flake struck –apparently at a slight angle- from the apex of a cobble. The ventral face is the unmodified cortex of the cobble and follows the cobbles natural curve. The dorsal surface is relatively flat, with some specimens showing the original lines of percussion, while others are uniformly flaked to remove the bulb of percussion.”

“Each artifact is flaked unifacially around its entire edge, until the tool is quite hoe-shaped. The primary working edges are slightly convex and have edge angles ranging from 53° to 62°. Distal working edges show signs of light dulling or polishing. The nibbling and deeper striations which tend to characterize gouges that were used to modify wood or bone are either absent or not pronounced. At least two specimens show polishing on lateral edges as well. The artifact’s polished, rounded edges may indicate that the tools were used to scrape more pliable materials than wood or bone, since the edges of

wood-workign gouges would have more likely been worn plainly across the angle of utilization” (Stevenson 1992:4)

Further, the artifacts from EgNr-8 were found in close proximity to one another, forming a cache. No diagnostics were recovered with this cache. Stevenson (1992:3), who found the site, noted that the artifacts were similar to those from EgNr-8, located close to the Camp Rayner (EgNr-2) site.

The EgNq-18 collection was briefly studied for this project, as it was not until the very end of writing the thesis that the author was made aware of this collection. Nonetheless, a total of 131 artifacts were recognized as Eldon unifaces (listed in Table 3.1). These artifacts were separated into the previously established types of Eldon unifaces. Happily, outside of 3 artifacts, the EgNq-18 collection agreed with the previously proposed 4 Eldon uniface types, helping to support the notion that the types are correct and real. Further, 18 likely Eldon uniface preforms and 4 unmodified spalls were also encountered in this collection. It seems that this collection represents a lithic workshop where Eldon unifaces were manufactured but not used. Although only briefly studied, it appeared that these artifacts ranged in *quality* in the sense that 9 broke during manufacture, while many of the completed forms were thicker than the average for Eldon unifaces elsewhere and had numerous failed flake removals from the edges. It is therefore likely that there were people learning how to make these tools alongside more experienced flintknappers (Stout 2002); the identification of learning and skill in flintknapping is discussed more thoroughly in Chapter 4.

On the same portion of shoreline as EgNq-18 was another cache of artifacts, but this time composed entirely of stone pestles (Stevenson 1998). Like the previous sites of EgNq-18 and EgNp-63, the artifacts were found in a small area and likely represent a cache. Another similarity is that the cache of pestles may represent a lithic workshop and learning. There was a noticeable level of variability within the cache, although the general ‘bell shape’ was adhered to in each piece. Further, not all of the lithic materials were the same, with sandstone examples being more often broken than limestone or dolomite, which are more commonly used for pestles. The usage of more abundant, and in a way cheaper lithic materials by inexperienced knappers was recorded from other

sites and helps support the notion that people were learning to shape stone at EgNq-15/16 and EgNq-18 (Bleed 2001; Stout 2002; Gowlett et al. 2005).

Table 3.1 List of artifact types from EgNq-18 (N=131).

Classic	63
Classic (Siltstone)	2
Classic with flake pattern of a loafing core	1
Corner Eldon	13
Unmodified cobble spall	4
Broken Classic	9
Preform	18
Round, Amorphous	16
Triangular adze	3
Side Eldon	1

Gowen (FaNq-25 & FaNq-32)

(N=34, Classic=16, Angled=4, Amorphous=1, Pebble Tool=13)

The Gowen site is the best-studied site in Saskatchewan with Eldon unifaces. The site dates to the early Middle Period (6,000 BP) and is located in Saskatoon, Saskatchewan along a terrace above the Saskatchewan River (Walker 1992). In actuality these have been recorded as two sites that are in close proximity to one another: FaNq-25 and FaNq-32. The sites, excavated by Dr. Ernie Walker, were a bison butchering and processing camp. The faunal assemblage was highly processed, with emphasis placed on obtaining marrow and grease from the bones. The sites were occupied for only a brief period of time during the late summer or early fall months.

Walker (1992:55) originally referred to Eldon unifaces as *gouges*. They were cautiously assigned a scraping plane function, based on the Walker's experience in the American Southwest with similar artifacts (personal communication Walker, 2008). Morphologically, the artifacts were described as

“usually triangular or semi-triangular with a few approaching a rectangular outline. Typically the wide distal end is the working edge, while the tapered proximal end often shows a striking platform remnant. All of the gouges are fabricated from large quartzite decortication flakes or from split chert pebbles. At least three are made from former bipolar cores.” “...the most distinctive feature of these gouges is the appearance of the working edge. The working edge is usually convex to straight, but a few display a concave or scooped-out margin. Virtually all are ventrally convex in cross-section, following the curved contour of the pebble or cobble surface. These features are reminiscent of adzes or gouges. In other respects these implements are similar to oversized endscrapers, but differ in that scrapers nearly always have flat ventral faces” (Walker 1992:55).

Wright (2006:132-133) also discussed Walker’s gouges. Wright differentiated Walker’s gouges from ‘polished’ stone gouges of the east, noting the importance of retaining the cortex along the working bit edge and perhaps disliked the term ‘gouge’ as Wright continually used the term in quotation marks. According to Wright (2006:13-133), the retention of the cortex “[was] the most durable portion of quartzite cobbles [and] it [made] sense that edges were used as the cutting portion of the tools”. The function was postulated as “involving wood and bone” with a scraping action (Wright 2006:132).

Eldon unifaces from this site were considerably smaller than any of the others in this thesis’ sample. Not all of the artifacts were made from quartzite either, as some were made from siltstone or chert; quartzite was nonetheless the most common lithic material recovered from the sites. The difference in size and material was likely related to the locally available raw material and not a product of a difference in function, although as discussed in Chapter 6, the small size might be related to a strategy of frugally utilizing resources like that of how the faunal assemblage was or related to a difference in function that was associated with similar artifacts from British Columbia: cobble spall tools.

Douglas Park Sandhills Sites (EgNn-9 & EgNo-23)

(N=3, Classic=3)

Two multi-component sites (EgNn-9 and EgNo-23) with Eldon unifaces were excavated as part of a salvage project (Neal 2006). The sites were located southeast of the town of Elbow, Saskatchewan, just northeast of Lake Diefenbaker in the Douglas Park Sandhills

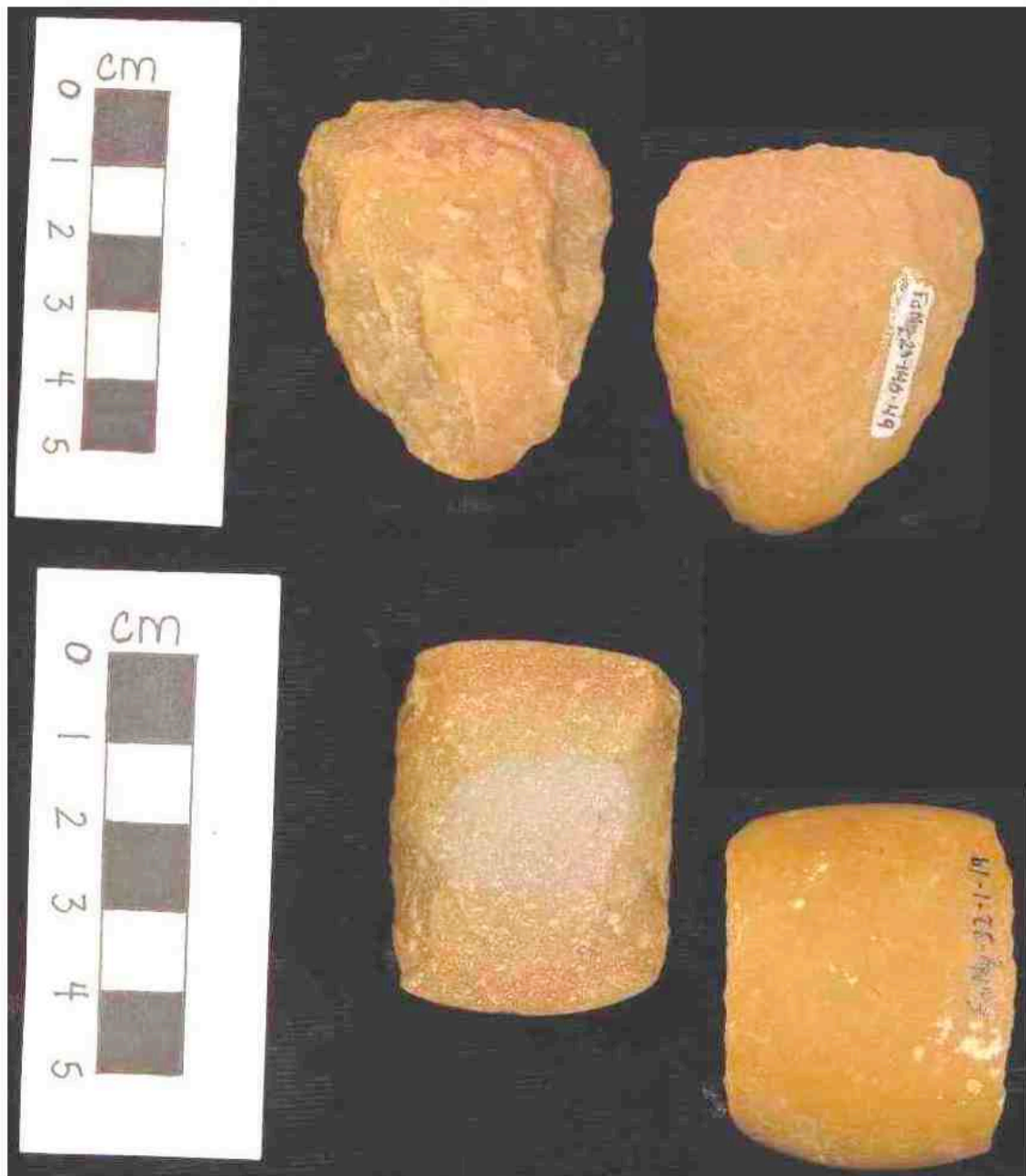


Figure 3.5 Eldon unifaces from the Gowen site. Left side images are of the dorsal face, and right of the ventral. Top is of a Classic Eldon and bottom of a Corner Eldon.

of south-central Saskatchewan. Processed bison faunal material and evidence for hearths and boiling pits were noted at EgNn-9, all dated to the last 5,000 years. Diagnostic points were also recovered, such as Late Precontact triangular, Avonlea, Sandy Creek (Oxbow), and Pelican Lake (Neal 2006:15, 48). There were two further occupation levels that had

no diagnostics or associated radiocarbon dates. A single Eldon uniface was recovered from a disturbed context and might belong to these lowest occupations (Neal 2006:17) (Figure 3.6). This disturbed context was the product of the initial pipeline construction where Neal returned to the site to collect disturbed artifacts found on the surface following site impact. Since the Eldon uniface was from a disturbed context, and that none of the previously mentioned sites with Eldon unifaces were dated to later than 5,000 years-ago, it is feasible that the artifact belonged to the lowest occupations and that this occupation might be pre-Oxbow.

Two Eldon unifaces were additionally recovered from EgNo-23 (Neal 2006:88). This site was similar in date and function to the EgNn-9 site. Another similarity was that the unifaces were derived from a disturbed context and the site had a number of lower occupations without dates or diagnostics.



Figure 3.6 Eldon uniface from EgNo-23 Image on left of dorsal surface, and the image on the right is of the ventral surface.

Surface Collections, Various Locations

(N=32, Classic=20, Angled=4, Amorphous=6, Side=2)

There are two large surface collections used in this thesis. The first is a collection used by the University of Saskatchewan's Department of Archaeology teaching classes. The second is that of the late Tom Phenix generously denoted to the Department of Archaeology by his wife Rose. Most of these artifacts were recovered around the

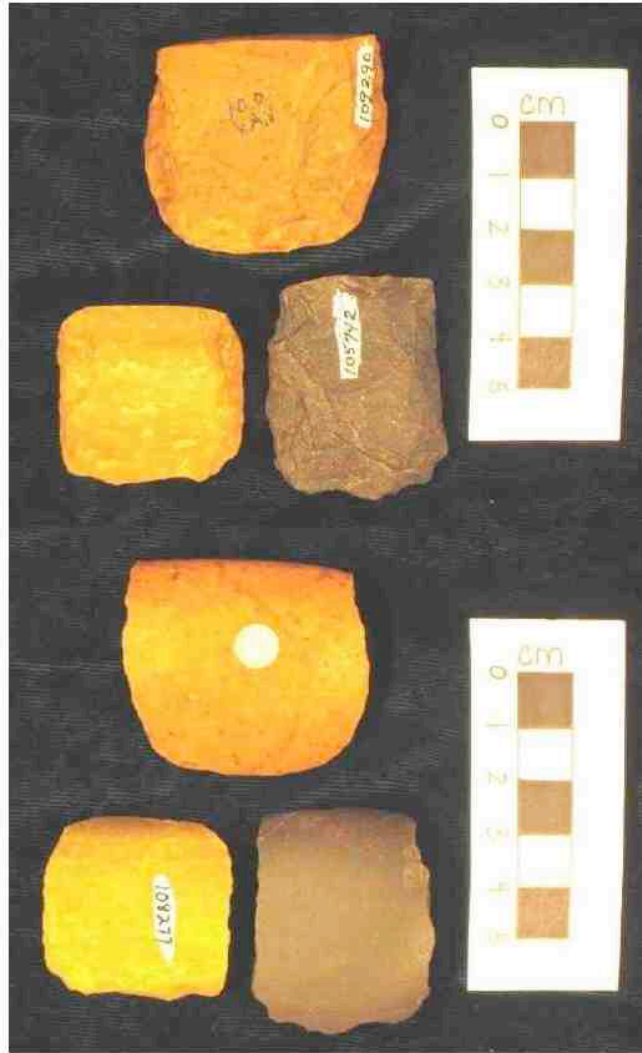


Figure 3.7 Three Corner Eldon unifaces from Saskatchewan surface collection (top: dorsal, bottom: ventral).

Saskatoon area, as Mr. Phenix was a resident of the area. Other local residents likewise donated the materials to the teaching collection, although some may have come from more southerly regions of Saskatchewan. Nonetheless, it would be safe to assume that all of these artifacts are local to the province and the majority found in the region around Saskatoon (some of these similar artifacts from the surface collections are presented in Figures 3.7 and 3.8). This suggests that there was another early-Middle Period site with an artifact assemblage similar to that of the Gowen site somewhere in the Saskatoon area.



Figure 3.8 Six Classic Eldon unifaces from Saskatchewan surface collection (top: dorsal, bottom: ventral).

3.2.2 Alberta Samples Context

The Alberta sites with Eldon unifaces were similar in date, environment, and type to those previously discussed from Saskatchewan. An important difference, however, is that they are spread over a larger geographical region. The locations of these sites are depicted in Figure 3.9 (the green polygon next to DjOn-26 represents the extent of the Cypress Hills).

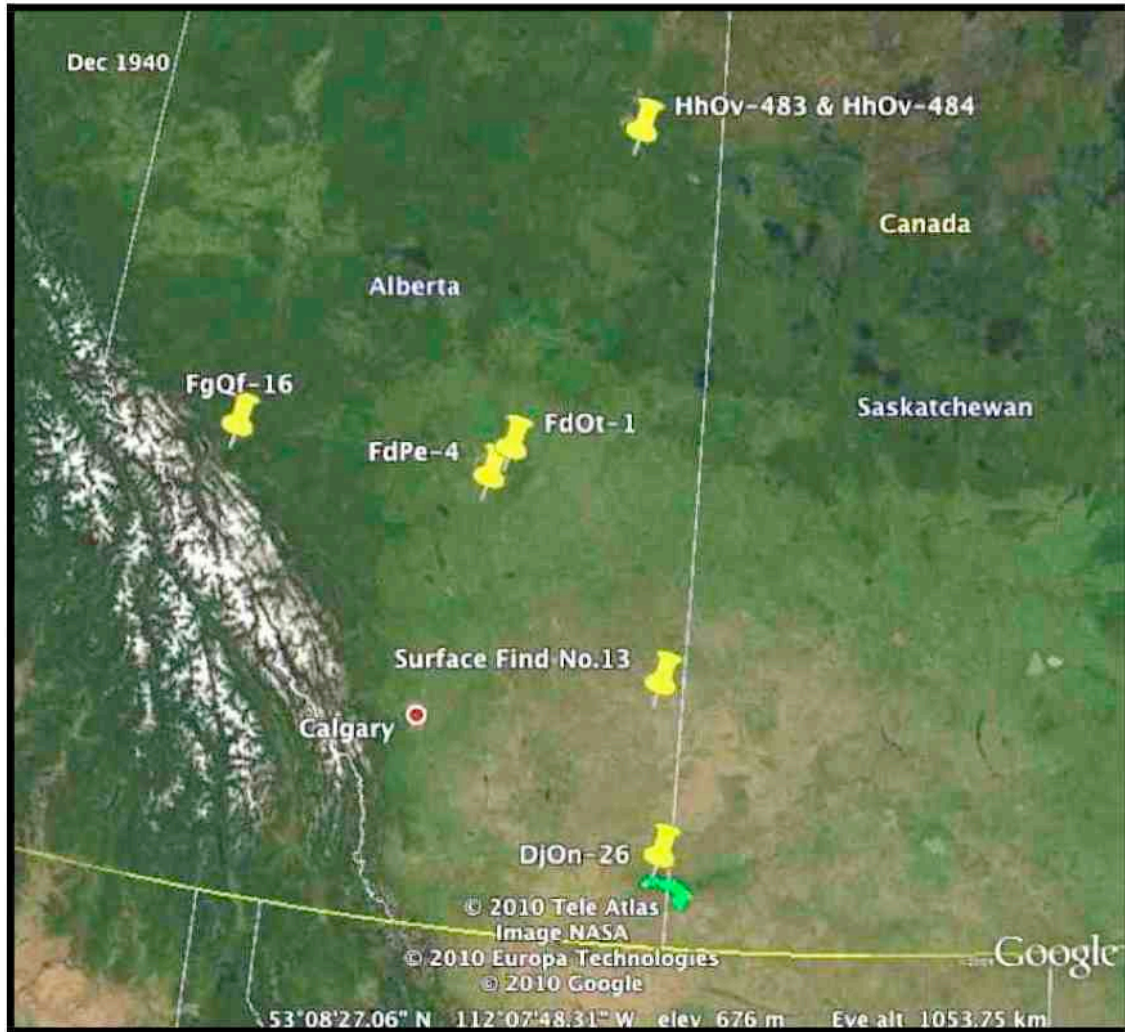


Figure 3.9 Location of sites discussed below in Alberta (created on Google Earth 5).

Upper Lovett Campsite (FgQf-16)

(N=10, Classic=10)

Located on a terrace above the Lovett River in the Foothills of west-central Alberta is the multi-component FgQf-16 site (Meyer and Roe 2008). Excavated by Lifeways consulting, between 2005 and 2008, this massive site had 14 Eldon unifaces, but only 2 were complete. The earliest components of the site were dated to the early-Middle Period based on the presence of Bitterroot



Figure 3.10 Eldon uniface from FgQf-16.

points. The Middle Period in this region was divided into three phases: Wallace Phase (7,750-7,000 BP), Embarras Phase (7,000-4,000 BP) and the Lovett Phase (4,000-3,000 BP). Eldon unifaces are associated with the Embarras Phase.

Eldon unifaces were referred to as ‘reverse unifaces’ and were recorded at other sites nearby to FgQf-16, also along the eastern slopes of Alberta (Meyer and Roe 2008). Although this thesis lists only 14 Eldon unifaces, Meyer and Roe (2008) originally listed 21 (Figure 3.10 depicts one of these Eldon unifaces). These artifacts were analyzed but significant differences were noted and they were hence labeled as other artifact forms, commonly what Meyer (personal communication, 2009) had called loafing cores. All of the unifaces were made from local quartzite materials and Meyer and Roe (2008) characterized the ‘reverse’ unifaces as

“exclusively unifacial, where the ventral surface of a large quartzite spall is percussion flaked and the dorsal surface, the outside of the cobble, is left unmodified. Another interesting feature of these stone tools is found in the debitage produced during the manufacturing process. The striking platform of many large shaping and thinning flakes can have extensive platform preparation scarring on the dorsal side and cortex on the ventral. Our preliminary analysis of these tools has shown that the broader of the two

short ends can exhibit usewear traits that are consistent with working harder materials such as bone or wood”

While associated debitage from manufacturing Eldon unifaces was mentioned by the authors, the debitage was not analyzed in this thesis.

Stampede Site (DjOn-26)

(N=2+)

Excavations were first conducted at the Stampede site in the early 1970's and, after a long hiatus, resumed in 2000. Located in the Alberta side of the Cypress Hills, the site is situated at the base of a large hill next to a creek. Large lakes are also close by and it was reasoned that bison herds congregated in the area during certain times of the year (Leyden et al. 2006). This is a multi-component site with artifacts dating from the Contact to early-Middle Periods and, perhaps, well into the Palaeoindian period. During the Altithermal, this region was inhabited because it offered a refuge from the less desirable regions around it that had little water and vegetation due to the harsh climatic conditions (Leyden 2004). The faunal assemblage at that time was primarily of bison remains that were “a highly processed ... [and] typically associated with a domestic camp setting” (Vivian et al. 2008:99).

During the initial excavations at the Stampede site, led by Eugene Gryba in the 1970's, a 7,000 BP component was uncovered that had multiple cobble spall tools (Klassen 2004; Robertson 2006; Wright 2006:132; Eugene Gryba personal communication, 2009). I did not analyze these tools, but Lifeways of Canada Limited identified two artifacts as ‘reverse unifaces’ from their most recent excavations (Vivian et al. 2008). These recent artifacts were briefly viewed by myself when visiting Lifeway's office. They are both made of quartzite (catalogue No. #207220 and #207221). Loafing cores were likewise identified and associated with the Eldon unifaces, similar to the Upper Lovett Campsite. One of the Eldon unifaces was located in component 11 and the other in component 9. These two components date to 6,000 ya and are assigned to the Bitterroot complex of the early-Middle Period. These dates agree with the ages from the Upper Lovett Campsite and Gowen sites. The component 9 artifact (#207221) is comprised of dark green quartzite with a darker cortex surface (Vivian et al. 2008:67). The plan view of the artifacts is rectangular with a slightly rounded and bi-convex

transverse cross-section. Vivian et al. (2008:67) further suggested the presence of polishing along the cortex /dorsal surface. The second artifact, from component 11 (#207220) is comprised of quartzite, green on the flaked surface and red on the cortex (Vivian et al. 2008:91). The plan-view of this artifact is elliptical with a plano-convex. All four sides of the artifact were flaked but the proximal region had less and more haphazard flaking. The distal edge was also convex and more pointed, giving it the appearance of a classic Eldon uniface. Like the first specimen, this too has polish but restricted to the distal margins on the cortex surface.

Boss Hill site (FdPe-4)

The Boss Hill site is located in central Alberta on the shore of Buffalo Lake. This multi-component site is situated atop and down the slope of a hill (called the Boss Hill) that overlooks the small lake (Doll 1982). The site dates to roughly 7,500 ya of the early-Middle Period and late Plano culture (Doll 1982; Wright 2006:132). It likely acted as a temporary campsite (Doll 1982:34).

A number of different artifact forms were recovered, including bone and antler tools. Of the lithic assemblage, 38.82% was of local quartzite material. Of interest, debris from bipolarly split pebbles was recovered alongside uniface stone tools with cortex along much of one surface (Doll 1982:45). The description of these tools was similar to Eldon unifaces:

“The left margin exhibits a casually worked sinuous cutting edge, while the right margin and distal end are unifacially retouched forming a fine beveled edge. This specimen is made on a large decortication flake with the cortex retained on the ventral surface and running to the working edge. Cutting and scraping functions are indicated for this tool, and the unifacially worked edge shows evidence of usewear” (Doll 1982:45)

These artifacts were generically described as cobble spall tools and choppers (Doll 1982; Wright 2006:132). The quartzite cobbles were split in half and edges lightly modified (Doll 1982:50). The cobble cortex was left intact only along the working edge of two of the tools (Doll listed these as specimens 60 and 61), while cortex covered the entirety of the dorsal surface of two of the other artifacts (listed as specimens 62 and 63) (Doll 1982:50-52). Only one



Figure 3.11 Two large chipped stone tool from the Boss Hill site (redrawn from photograph in Doll 1982:51).

edge was modified on 62 and 63, but three edges were modified on 60 and 61. Although only artifacts 60-63 were specifically mentioned, Doll (1982:48) also noted that many more of the unifacial tools were made from decortication flakes that had one side or end worked, but the cortex face of the tool had *no* flakes removed. These artifacts were further small with variable forms. Two of these artifacts were characterized as *large chipped stone tools*, with accompanying photographs that were similar to the Eldon uniface from the Stampede site (Doll 1982:50-52) (Figure 3.11). These artifacts differ from the Eldon uniface discussed in this thesis in that they are larger, have slightly serrated edges, larger flake scars, and the edge modification is less formal and patterned. These differences are likely due to the artifact's slightly earlier age and the Classic Eldon uniface may represent a change in morphology over time. The artifacts were furthermore not analyzed for this thesis.

Anderson site (FdOt-1)

Located in east-central Alberta, the Anderson site had multiple occupations that were referred to as ‘sporadic’ (Quigg 1984:151). The earliest component was dated to 4,700 ya and had an associated Bitterroot point. Today, the region’s landscape is aspen Parkland but during the Bitterroot occupation the area was a grassland environment.

The lithic assemblage was comprised principally of local quartz and quartzite materials, composing 80% of the assemblage (Quigg 1984:153). Artifacts of the Bitterroot occupation consisted of bifaces, endscrapers, unifaces, an anvil, hammerstone, retouched flakes, and flake debitage. The tool assemblage was characterized as representing “expedient, expendable, or low-value tools that were manufactured, used, and then discarded during abandonment of the site” (Quigg 1984:156). Alongside the Bitterroot lithic assemblage were highly fragmented bison bone elements and two likely Eldon unifaces were likewise associated. The two unifaces were described with cortex covering the entirety of one surface and the opposite surface having at least 50% modification (Quigg 1984:154). The artifacts were originally struck from a cobble and the “worked surfaces have short, broad flake scars with crushed platforms, implying that hard hammer percussion had been applied during manufacture” (Quigg 1984:154).

Southeast Alberta Surface Find

(N=1: Side=1)

One isolated Eldon uniface was recovered by Jeremy Leyden of FMA consulting on the surface of a plowed field near Oyen, Alberta. One lateral edge of a smoothly split quartzite cobble was steeply flaked (Figure 3.12). Best described as a cobble spall with lateral flaking, this artifact was labeled as a Side Eldon uniface. This is the only surface find from Alberta that is included in this study.

Boreal Forest of Northern Alberta Sites (HhOv-483 & 484 sites)

(N=2: Classic=2)

Two Eldon unifaces were recovered from two adjacent sites north of Fort McMurray in northern Alberta. FMA Heritage consulting excavated both sites in 2006 (Laura Roskowski personal communication, 2007). Beaver River Quartzite (BRS) dominated

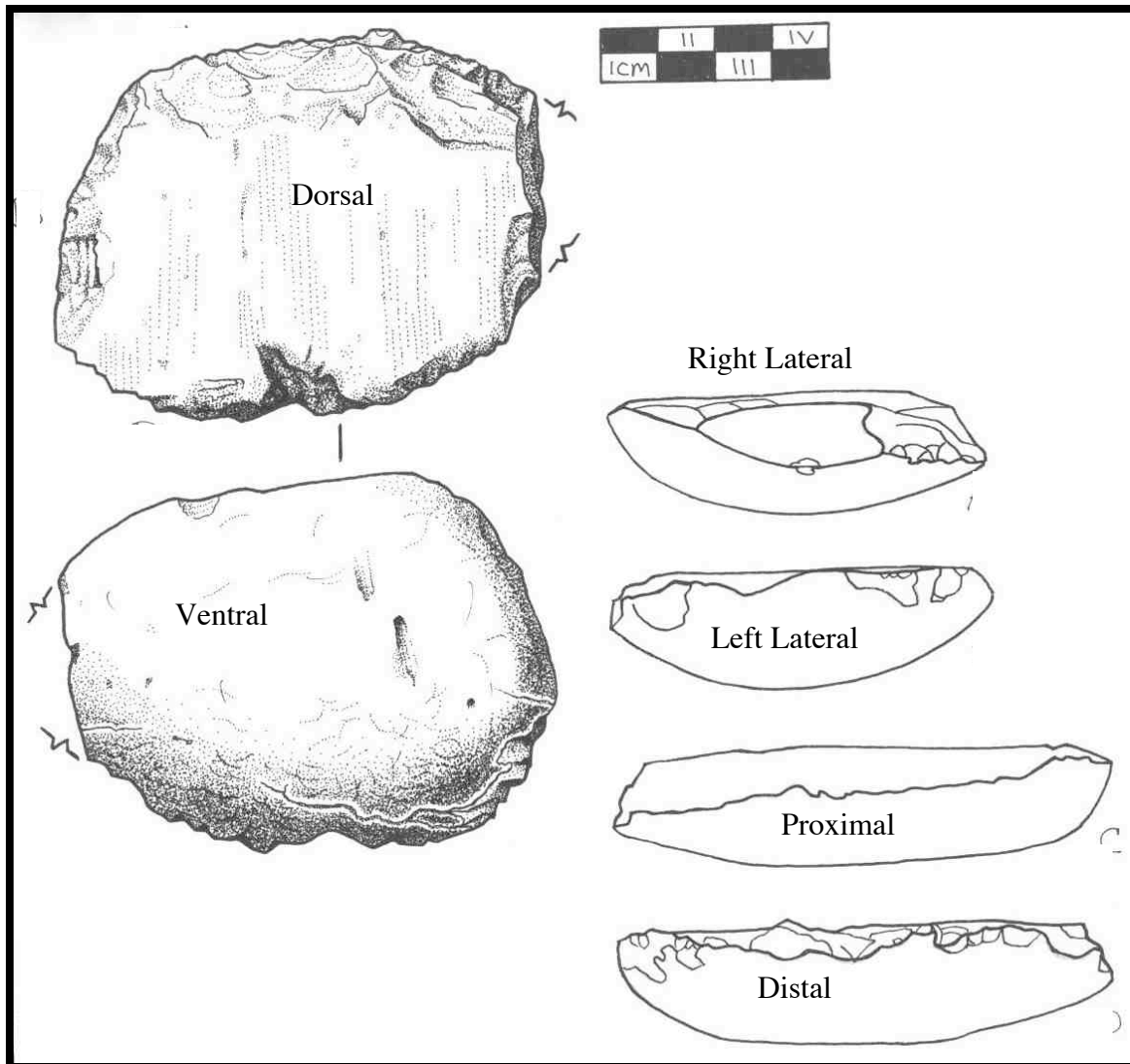


Figure 3.12 Side Eldon uniface from disturbed context near Oyen, Alberta. Top is of the dorsal surface, below that is the ventral surface, and associated lateral, proximal, and distal views on the bottom right.

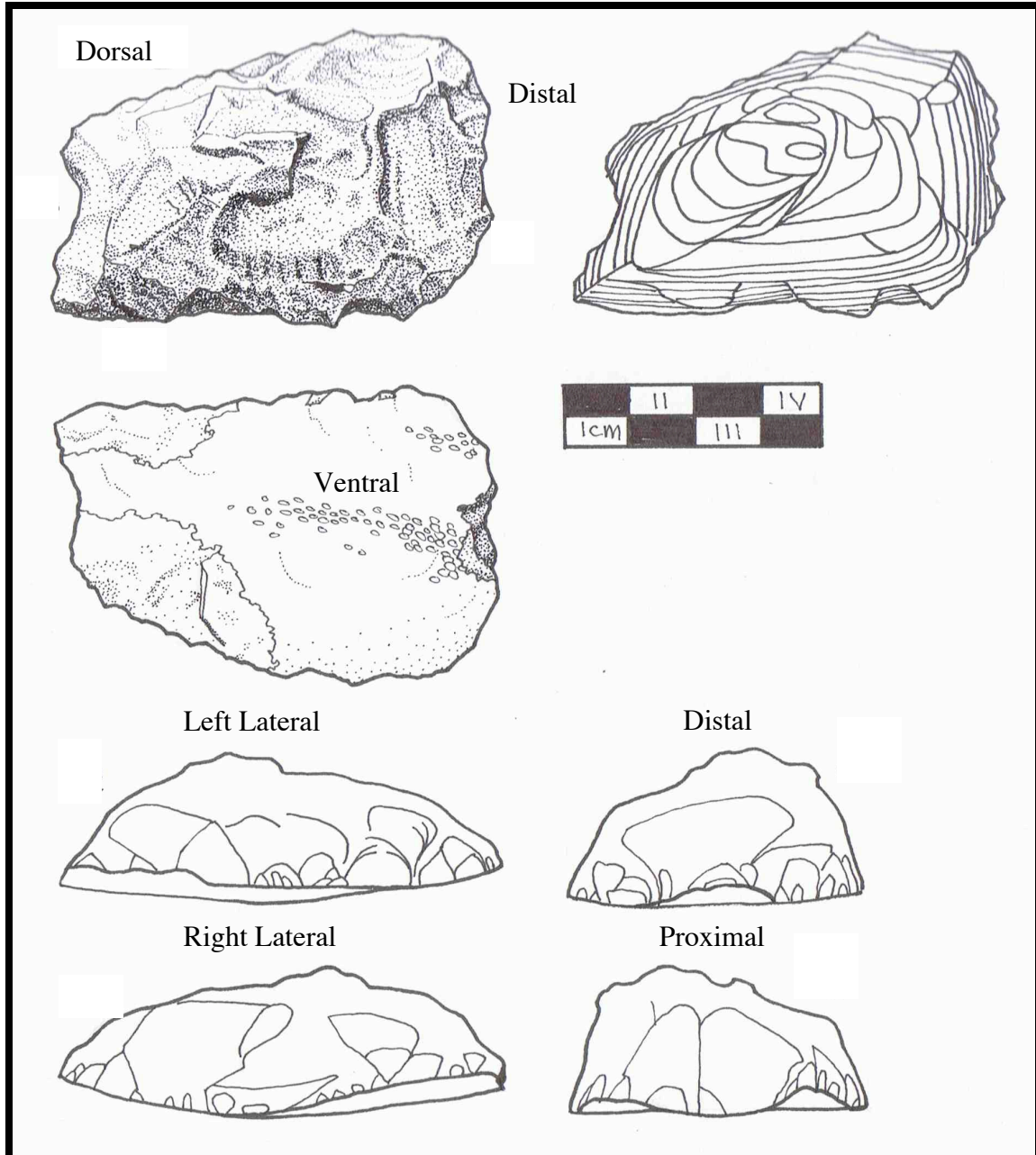


Figure 3.13 Classic Eldon uniface from HhOv-484. Top is of the dorsal surface, below that is the ventral surface and associated lateral, proximal, and distal views. Top-right corner is a contour map styled view of the artifact's dorsal surface.

both lithic assemblages, but the Eldon unifaces were instead made from quartzite (eg. Figure 3.13). There were few organic remains due to the acidity of the soils, and hence there were no associated dates and a residue analysis of the artifacts did not result in any positive findings (Laura Roskowski personal communication, 2008). Further, with little soil accumulation in the region the site was not stratified and was partially compressed, making it difficult to associate the artifacts with the few diagnostic points. Nonetheless, the sites were described as habitation sites with multiple tool types represented.

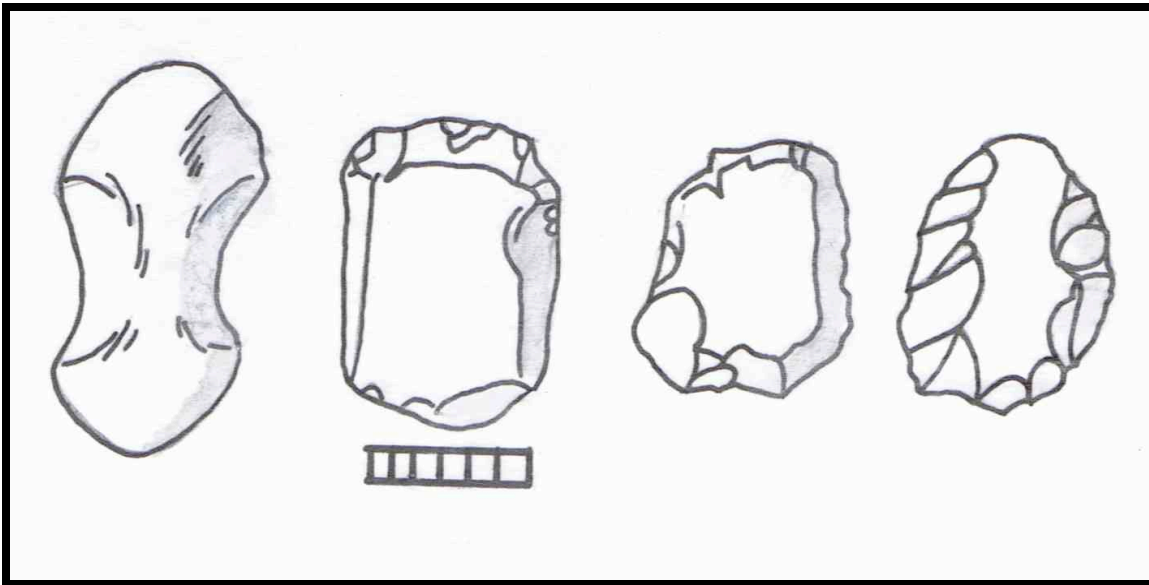


Figure 3.14 Lac La Biche artifact; from left to right: notched cobble, two adzes, and one marginally retouched split cobble (redrawn from photograph in McCullough 1982).

McCullough and Wilson (1982) reported cobble spall tools at sites from northeastern Alberta near the HhOv block, which were indicative of Eldon unifaces. Even so, there was no detailed description accompanying the list of artifacts. In another publication, McCullough (1982) reported on surveys in portions of the Lac La Biche region in northern Alberta. In this paper, a plate of artifact photographs was published. The grainy black and white photograph depicted a notched cobble, a marginally retouched split cobble, and two “notched split cobbles” referred to as ‘adzes’ (McCullough 1982:165). All of these artifacts are depicted in Figure 3.14, with the second from the left being the closest in shape to Eldon unifaces, in particular those from

Saskatchewan. Upon speaking to McCullough (personal communication, 2008), the author was informed that the survey's collection was lost.

3.2.3 Limited to Only Saskatchewan & Alberta?

Eldon unifaces are rarely found in the northern boreal forests of Alberta and are not known from the Saskatchewan northern boreal forests. According to Kasstan (2004:108-109), and likely referring to only Saskatchewan, no Eldon unifaces had been found in the boreal forest. These tools are also not present in Manitoba or British Columbia. The geographical extent of these artifacts is circumscribed from central Saskatchewan to southwestern Alberta, stretching across southern Saskatchewan all the way to southern and northwestern Alberta into the mountain ranges and tapering into the northern boreal forests of Alberta. No evidence was found in the literature to suggest these artifacts are present in the United States. This geographical extent indicates that this artifact type might be a hallmark of the Canadian Plains toolkit. The artifacts in the Alberta boreal forests might signify cultural interaction between groups residing in the Plains and boreal forest; however, this interaction was not reciprocated in Saskatchewan nor Manitoba. This lack of interaction proposes ethnic boundaries, but this argument is footed on loose terrain.

3.2.4 Limited Similarities

Four sites mentioned above (Gowen, Upper Lovett Campsite, Anderson and Stampede) all have Eldon unifaces that date to the same time period: the early-Middle Period. These sites stretch from western Saskatchewan to western Alberta and the artifacts from the sites without dates are likely coeval to those with dates. Additionally, all of the above mentioned sites are habitation sites. All of the sites are similarly located near water sources and access to bison herds and trees. The location of these sites is likely a product of the period's climatic shifts to the Altithermal, but the similarities might additionally have bearing on Eldon unifaces. These similarities will be discussed again in connection to similar artifact forms in nearby areas such as British Columbia and Manitoba.

For the Aitkow 3 site, the formation of the tools that were left in one spot suggests the storage of tools for a future use (or site furniture), what Kuhn (1992b:188; 2004) referred to as *provisioning places*. A mobile group that forms a habitation site with

adequate food, shelter, and other amenities will also often produce “items needed in the future and in which the specific tools needed are known, one would expect the complete production of specific tools to occur during an occupation” (Larson and Kornfeld 1997:13). A storage of work additionally occurs, where work was expended on the creation of Eldon unifaces to be used at a later period of time. Chipped stones are not commonly difficult or time consuming to manufacture, but the Lake Diefenbaker cache’s quantity may offset this statement. Furthermore, a strategic problem of maintaining numerous tools with fresh edges may be alleviated through the creation of multiple Eldon unifaces (Kuhn 1992b:187).

Differences in the Gowen assemblage in comparison to other sites might be due to people using smaller stone nodules for tool construction. These smaller nodules may not have been what they had preferred to use, but the climate made areas near water sources pull them there and forego other campsite criteria such as more preferable (larger) stone material.

In regards to the types of Eldon unifaces recovered from the sites, the percentages are quite similar in the Saskatchewan sites (Figures 3.15, 3.16, 3.17, 3.18, and 3.19), but in Alberta the collections are composed entirely of the Classic type; except for one Side type found in a field. Further, this illustrates that Eldon unifaces were made and used in only one area and not transported elsewhere, which had sometimes unanticipated results such as the forced encampment at places with poorer lithic resources. All of this may indicate the placement of the Gowen site was reasoned on environmental constraints and finding of food (bison) while lithic availability was a tertiary concern.

In support of these similarities is the Mummy Cave (5,700 BP) dated Norby site (FbNp-56) located in Saskatoon (Zurburg 1991), Saskatchewan that does not have Eldon unifaces. It was reasoned that only a small portion of the site had been excavated as it was nestled inside the city. This was a winter-period bison kill site that had few flaked stone tools but the tabulation of lithic materials displayed the familiar pattern of predominantly local materials, and a little Knife River flint. A snow trap might have been used to capture the inferred 26 bison. The absence of Eldon unifaces may be a product not so much of the limited excavations but rather that they were not used in tasks associated with butchering bison. This is further supported by the artifact’s presence only

at habitation sites and not in association with bison butchering at the afore mentioned sites.

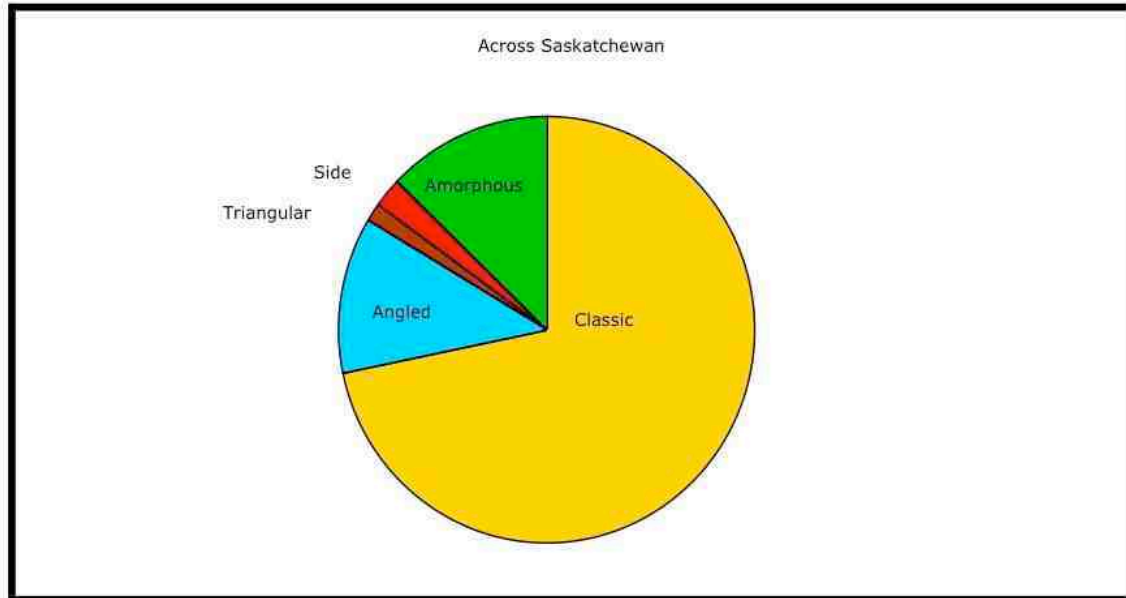


Figure 3.15 Percentage of total Eldon types across Saskatchewan.

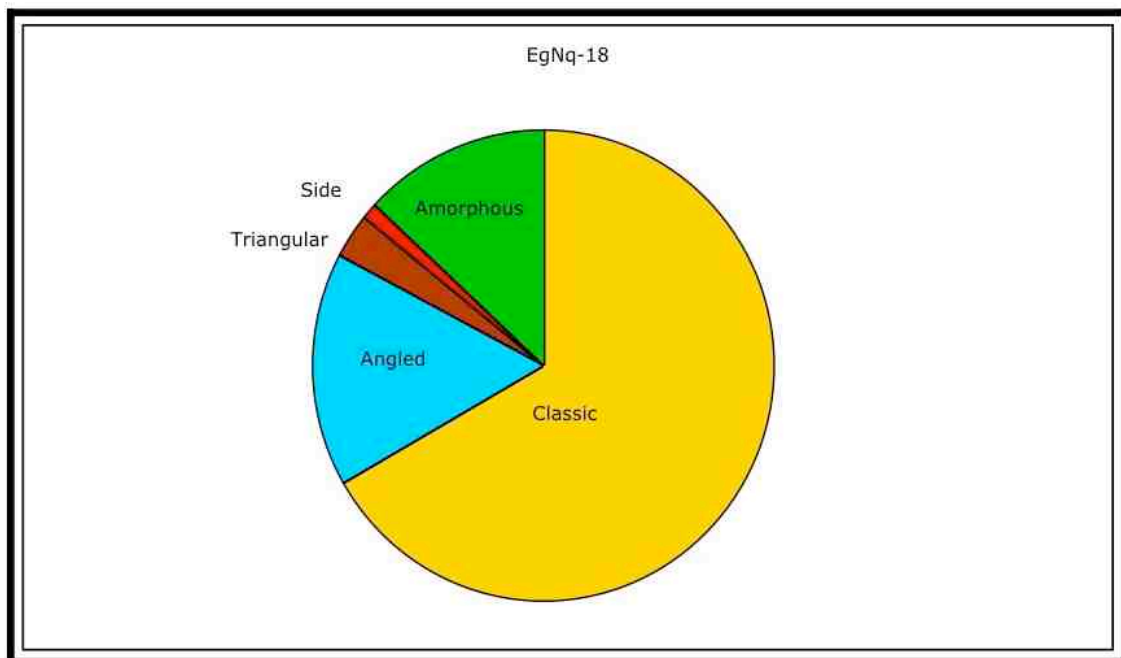


Figure 3.16 Percentage of total Eldon types from EgNq-18.

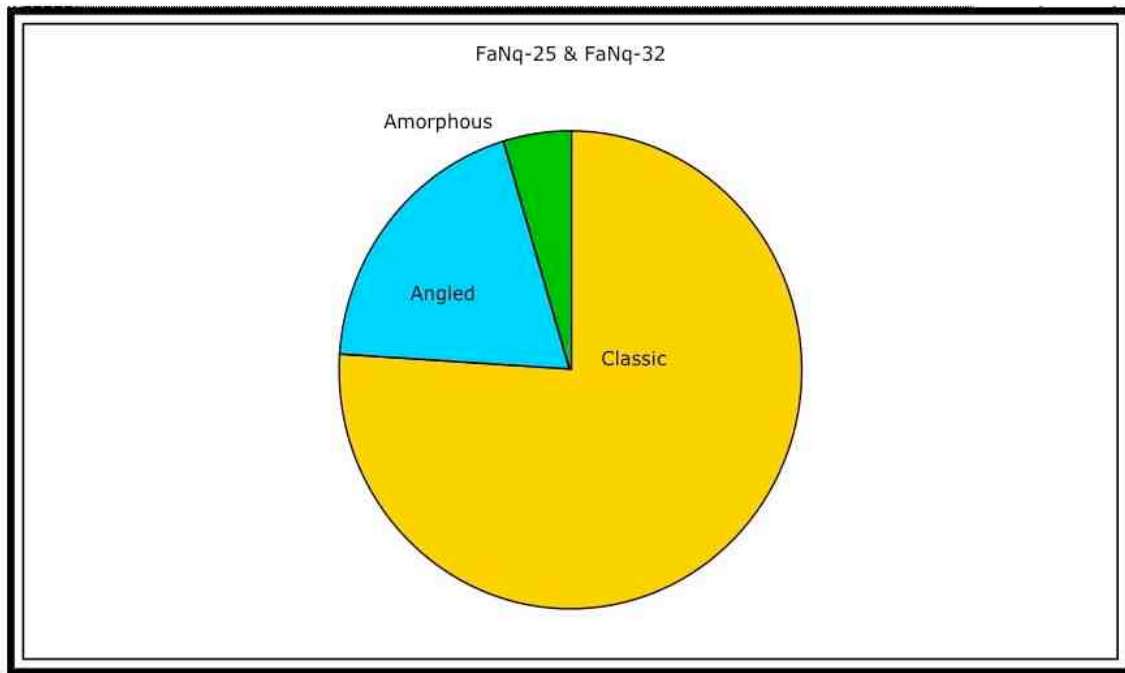


Figure 3.17 Percentage of total Eldon types from FaNq-25 and FaNq-32.

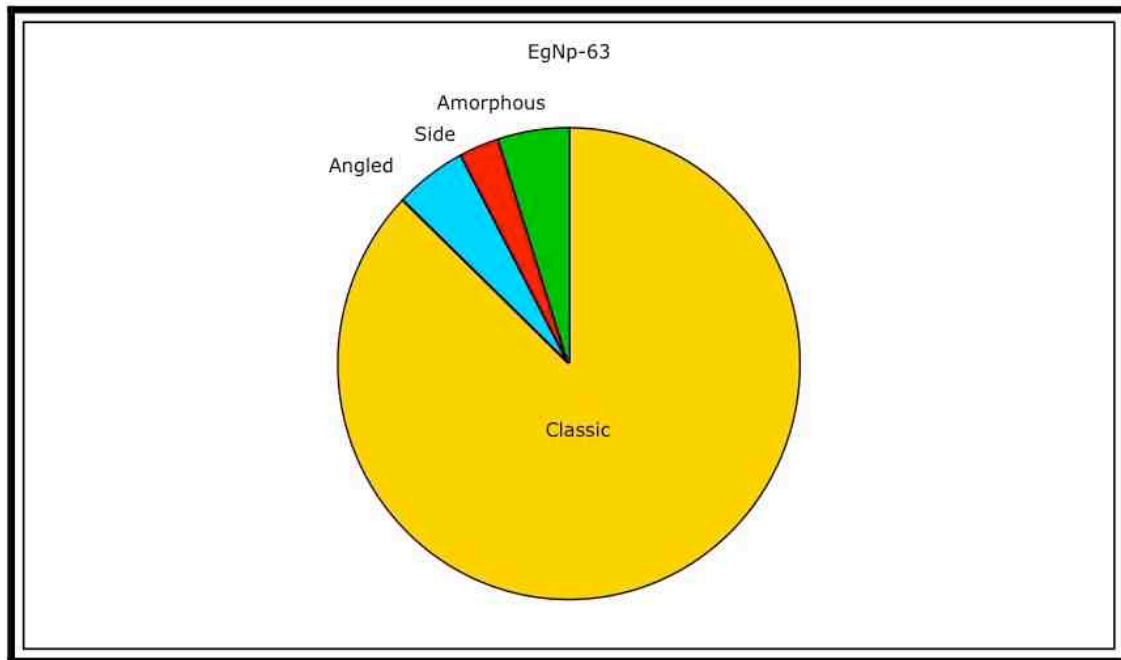


Figure 3.18 Percentage of total Eldon types from EgNp-63

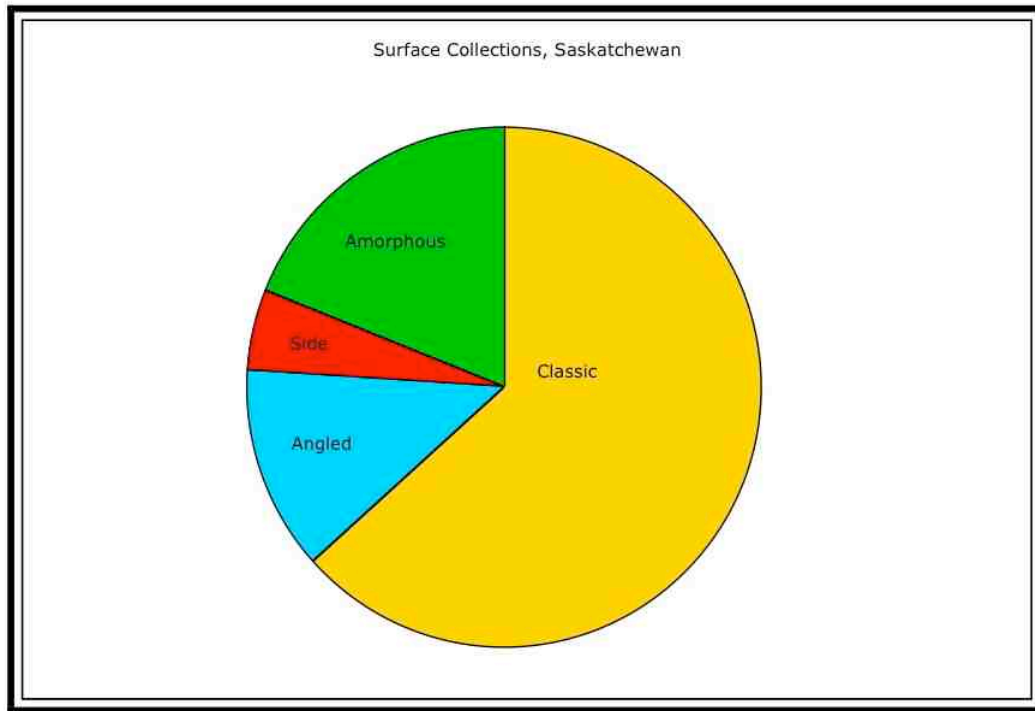


Figure 3.19 Percentage of total Eldon types from surface collections in Saskatchewan.

3.3 Similarities to Other Geographic Regions

Eldon unifaces are only known from Saskatchewan and Alberta, but are there similar artifact forms outside the two provinces? A slightly similar tool form was encountered during a survey of the literature from the Canadian Maritimes and Northeastern United States. These artifacts are called spall tools. They were described as having a “round to semi-lunar plan view with some flaking or grinding to produce a convex cutting edge” and cortex is sometimes retained along one surface (Sanger and Newsom 2000:9). This description suggests a level of morphological variability unlike the description for cobble spall tools in British Columbia.

Another type of artifact was also encountered from the Maritimes region that had a few similar traits. These artifacts are a distinctive type of chipped hammerstone that date to the early Middle Period (Sanger and Newsom 2000:6-7; Sanger 2008). Made from various porphyritic felsite stones, this chipped hammerstone had a bifacial-flaked ridge with angles of nearly 100 degrees (Sanger and Newsom 2000:6-7). The ridges were constructed through unifacially flaking one side and then turning the piece over to repeat the process, but retaining the rest of the cobble’s cortex, providing a limited similarity to

Eldon unifaces. Its ridges were battered and crushed and likely used to shape other stone tools through pecking. The gross morphology of this artifact seems similar to Eldon unifaces but for the battering and crushing which is not present except on the proximal areas that is related to hafting.

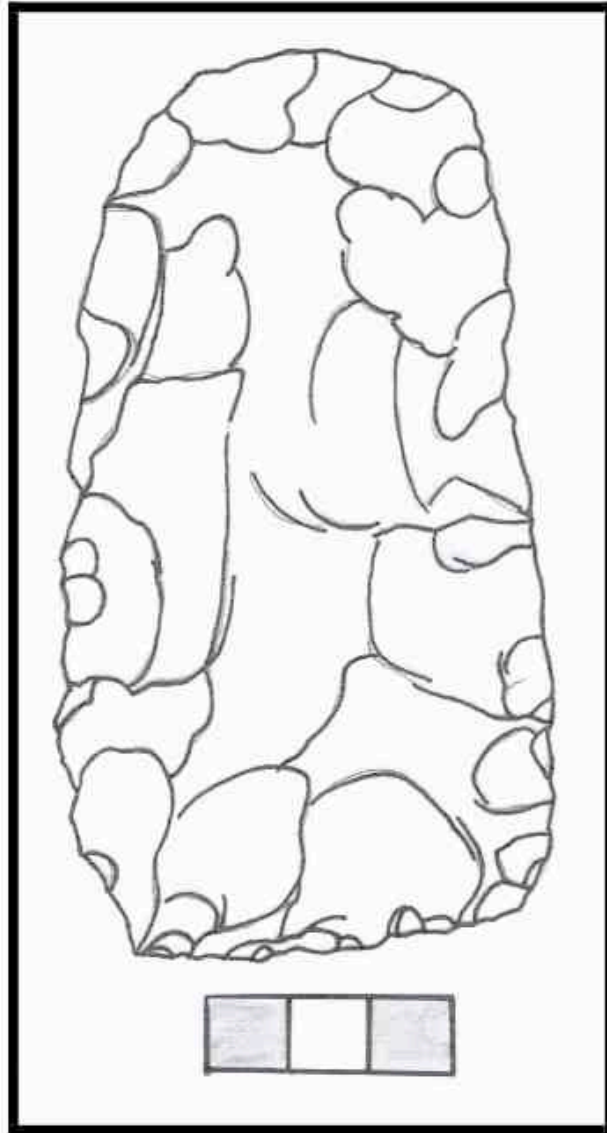


Figure 3.20 Chipped and ground adze blade from the Pinawa Bridge site (redrawn from photograph in Steinbring 1980:171). Distal edge facing down.

The literature from Manitoba does not offer any similar artifact forms. However, if Eldon unifaces were used as wood working tools, then the literature has numerous

examples of such artifact forms. Stone adzes are an artifact type found across Manitoba. There are numerous types of adzes from this province and some share similarities to Classic and Corner Eldon unifaces. One such adze that is reminiscent of Classic Eldon unifaces from EgNp-63 is depicted in Figure 3.20. This is a chipped and ground adze blade made of dark-green-black slate with a plano-convex profile and a ground flat ventral face, from the Archaic component of the Pinawa Bridge site along the Winnipeg River (redrawn from a photograph in Steinbring 1980:71). Although Figure 3.20 presents a specific type of adze blade, this section discusses Manitoba adzes in a general manner in defining this tool type and drawing some limited similarities between them and Eldon unifaces.

Adzes have steeply beveled dorsal surfaces and flat ventral surfaces (Clark 1974:86; Brownlee 1995). Figure 3.22 presents such an adze blade from the Coca-Cola Creek site, made from greenstone with a plano-convex profile, was bifacially prepared, and perhaps used for watercraft construction (redrawn from photograph in Steinbring 1980:221). The function of an adze can influence both its size and form (Clark 1974:88; Malasiuk 2001:31); this relationship may also pertain to Eldon unifaces as there is a degree of variability within each type. Distal edges are first bifacially flaked and then sometimes ground, pecked, or polished with the use of a whetstone (Giddings Jr. 1956; Buchner 1979 and 1982; Brownlee 1995; Malasiuk 2001:31). Clark (1974) claimed that adzes that were not fully ground were *incomplete*, although all authors do not hold this opinion since less or more grinding may relate instead to the task in which the tool was associated (Malasiuk 2001). More grinding was associated with an expedient tool where it was used for rough shaping, and tools with more polish associated with delicate work. A collection of adzes from the Churchill River survey had fewer than 30% of the adze blades with ground distal edges; however, 88% of the expanding bit type had ground lateral margins, to aid hafting (Brownlee 1995). Further, pecking occurred in only 9 of the 160 recovered adzes. Grinding was more common on particular lithic materials, like basalts, but less common with greywacke.

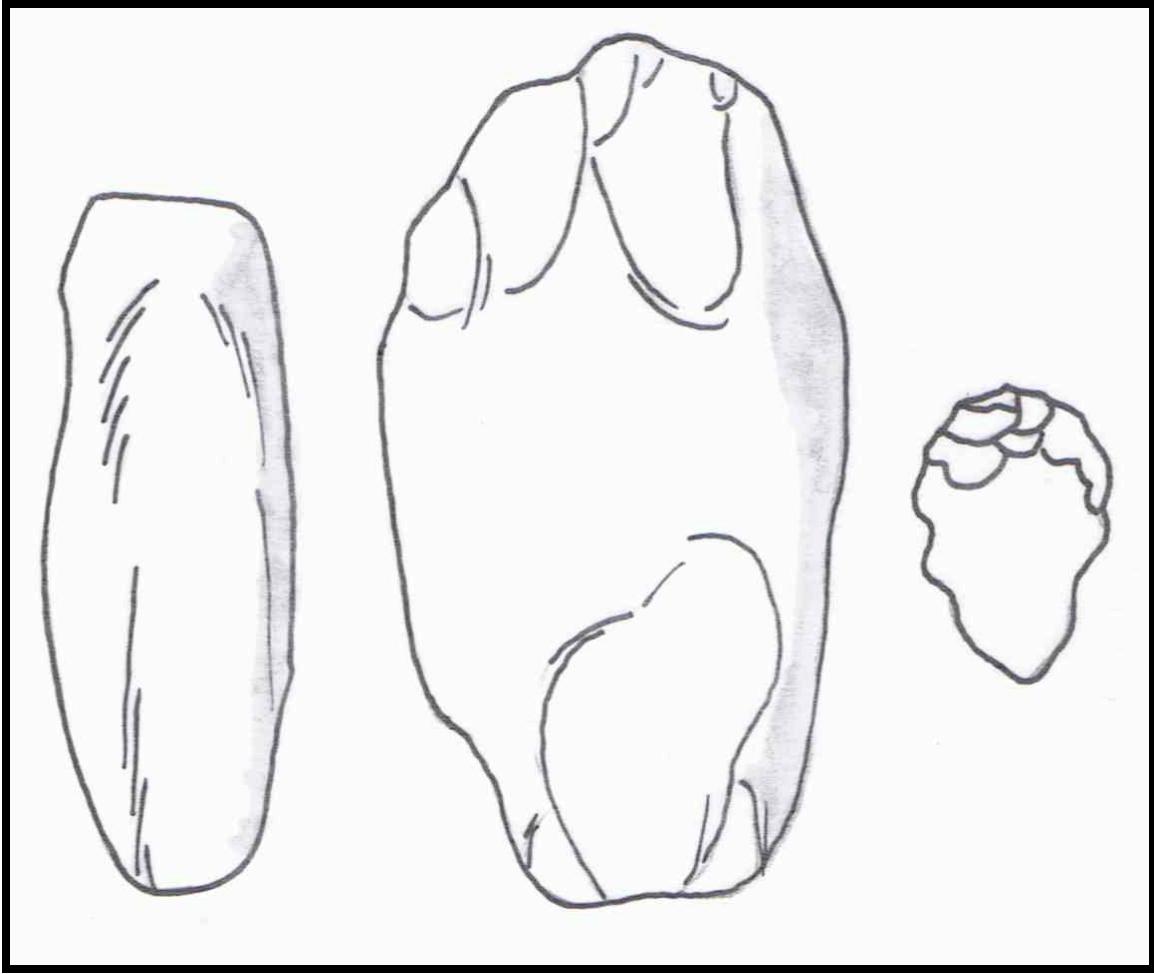


Figure 3.21 Three different adze blades from Manitoba (redrawn from Malasiuk 2001:33). Central artifact measures 14cm long.

Some of the Manitoba adzes relate to specific time periods, regions, and ethnic groups (eg. Malasiuk 2001); further, there are more than sixteen known varieties (Brownlee 1995) some of which are: rectangular, trihedral, expanding bit, transversely grooved, ovoid, bi-point, gouge, and chisel. Most of the adzes discussed here relate to the Plano and Archaic time periods. Figure 3.21 illustrates three widely varying types of adzes from Manitoba (redrawn from Malasiuk 2001:33).

Adzes became more common during the Intensive Diversification (ID) period of 8-2,000 ya and continued to be used until the Contact period (Malasiuk 2001:8-12). Although there are numerous variations of adzes in Manitoba that perhaps represent different ethnic groups or time periods, some broad generalities can still be outlined. As



Figure 3.22 Chipped stone adze blade from the Coca-Cola Creek site (redrawn from photograph in Steinbring 1980:221). Distal edge facing down.

inferred from a survey of the Churchill River in Northern Manitoba, these adzes range in size from 55-160mm in length and 8-37mm in width, with either symmetrical or asymmetrical edge profiles (Brownlee 1995). Although not a rule, symmetrical bit profiles are associated with an axe-like function and asymmetrical bits with adze-like functions such as hollowing out logs for canoe construction.

Geographically, transverse grooved adzes were more common in southern Manitoba. These tools tend to be thicker and larger, used for splitting wood. In northern Manitoba, adzes made from greywacke and basalt are more common (Malasiuk 2001:10). There is also a size increase of adzes during the Arctic Small Tool tradition (ASTt) movement into the boreal forest (Meyer 1977; Malasiuk 2001:12). From the Seahorse Gully site, two forms of adzes were noted (Meyer 1977:86-88). These were the stemmed and unstemmed rectangular adze blades that had biconvex cross-sections, bifacially flaked, with some polished portions. Along with the adzes were other large stone tools like scraper planes, chisels, and gouges; the latter of which may have been recycled into adze blades (Meyer 1977:86).

Overall, adzes were commonly made from hard lithic materials from local deposits (Brownlee 1995) such as greywacke, quartzite, quartz, and basalt, but softer stones like chert and siltstone were conjointly used (Malasiuk 2001:10). An example from the GILk-4 site in northern Manitoba presents one such adze made from a softer material (Malasiuk 2001:31). This chisel adze was made from siltstone, where the soft lithic material could be ground but was durable enough for use in forceful impacts. Chisel adzes are characterized by their expanding distal edges that were likely used to process wood in such tasks as to fell trees, remove bark from a tree, split wood, hollow out a log, and carve delicate items such as bowls (Brownlee 1995; Malasiuk 2001:56). An image of a chisel adze blade is presented in Figure 3.23 (redrawn from Malasiuk 2001:33). The stress of working a hard material such as wood often snaps the distal bits off experimental tools (Sands 1997; Hardy and Garufi 1998; Rots and Vermeersch 2000), which is encountered with many of the known adze blades in Manitoba. However, woodworking is not the only function of an adze. Buchner (1984) proposed two other possible functions for adzes such as digging soils for mining lithic materials, and chopping and separating bones when processing animal carcasses.

Bi-pointed adze blades are one particular type of Manitoba adze blade with a striking similarity to Corner Eldon unifaces (Brownlee 1995). Brownlee (1995) is one of the few authors to discuss these artifacts, but he provided only a minimal description of these tools besides noting that they had two opposing bit ends. This hallmark brings to mind Corner Eldon unifaces.

Trihedral adzes are a diagnostic of the Caribou Lake Complex, which dates to 8,000-6,000 ya and is depicted in Figure 3.22 (Buchner 1979:123). This complex also has strong associations with the Lakehead Complex of northwestern Ontario (Buchner 1984). One of these associations is found in the shared usage of chipped or ground stone adzes, which are likewise referred to as trihedral adzes. Some adzes of southern Ontario date to an even earlier culture, the Dalton (10,500-8,500 ya), which is primarily known from Missouri and Illinois, and had spread north into Ontario (Julig 1994:28). Their bifacially chipped adzes were likely hafted and possibly used to cut or shred skins and meat. Trihedral adzes are made from various lithic materials such as metamorphosed shale (Buchner 1984; Brownlee 1995). In regards to dimensions, their cross-section is of

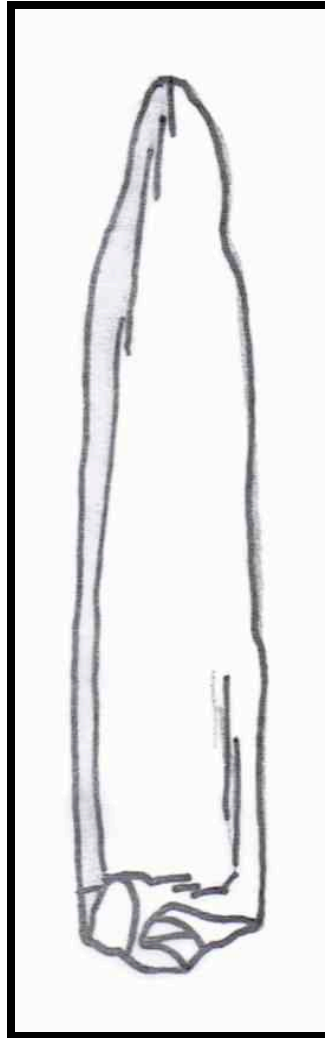


Figure 3.23 Chisel adze blade (redrawn from Malasiuk 2001:33). Distal edge faces down. No reference size.

an isosceles triangle “with the height...slightly greater than the length of the base... [and] the greatest width...between the bit and the mid-section”, and with slightly convex sides (Buchner 1979:75). The ventral face is a flat surface with occasional “longitudinal striations” which may be related to a particular function (Buchner 1984:75). There are likewise two similarities in respect to Eldon unifaces. The first is that for the Trihedral adzes, a “minority of the adzes [have] percussion-flaked ventral surfaces, and many of these bear a centrally-positioned convex ‘flaw’ which could not be removed.” (Buchner 1984:75). This type of thick central area is one of the attributes on the Eldon unifaces. This may be a similarity in knapping strategies in relation to how both tools were hafted and how hard lithic materials can be difficult to thin. Such a strategy may have been a common method of working stone as opposed to the approach of only a particular group. The second similarity was also likely a common method as opposed to a group’s particular knowledge of working stone. This is a similarity in that both Eldon unifaces and Trihedral adzes had dorsal faces that were worn and ground, but not “to the point at which all evidence of flaking is obliterated” (Buchner 1979:75). This is likely a similarity in that both these tools were hafted, which can wear and grind the proximal half of a tool’s surface. Nonetheless, three artifacts from EgNq-18 shared further morphological similarities with the trihedral adzes and chisel adze blades (Figure 3.24). These three tools are further unique for they have various dissimilarities to other Eldon unifaces but share the key attributes of retaining cortex along one face and being made from bipolarly flaked quartzite cobble spalls. The greatest difference between these tools is that they are not as thick as Trihedral adzes, but instead their measurements are more in line with the Classic Eldon uniface types. Unfortunately, the EgNq-18 collection was analyzed only at the end of this research project and these similarities can only be hinted at here.



Figure 3.24 Eldon unifaces from EgNq-18 that share similarities with adzes from Manitoba. Dorsal surface on left, ventral on right.

3.4 Northwest Coast – Interior British Columbia

Cobble spall tools from British Columbia and Eldon unifaces shared multiple similarities in their morphology, method of construction, and the types of sites they are found at. This level of similarity is not found anywhere else. This is not to detract from earlier statements that Eldon unifaces are unique, for they are still to be considered unique in *Saskatchewan* and *Alberta*. It is because of this level of similarity that British Columbia cobble spall tools are provided a lengthy discussion. Further, these similarities are referenced in the following chapters, in particular with the questioning of Eldon uniface function and how this is similar to cobble spall tools.

Numerous technological changes occurred during the Middle Period in interior British Columbia (BC). The BC Middle Period, dated to between 8,000 and 3,000 ya (Fladmark 1982:124), has been characterized as:

“Middle Period cultures were small, loosely organized groups that primarily exploited terrestrial animal populations. There does not appear to be the same dependence on anadromous salmon resources as seen in the Late Prehistoric, although the faunal evidence is very meager for such conclusions. The tool kits associated with the Middle Period were primarily of flaked stone and in many sites there was the presence of a developed microblade technology.” (Darwent 1998:20).

There are similarities between Middle Period artifact assemblages in BC's central to southern interior and the Canadian Plains, establishing group interaction (Sanger 1967). The point of demonstrating these similarities is to demonstrate that there are a number of technological links between BC and the Canadian Plains that imply a level of interaction that could explain why there are also striking similarities between the BC cobble spall tools (CSTs) (discussed below) and Eldon unifaces from the Canadian Plains. The connection between the Canadian Plains and BC was based on similarities in projectile point attributes (Sanger 1967:192). The points were recovered from the 6,000 ya Nesikep Creek site, located in the central interior. There, points with expanding stems and notched bases were very similar to Hanna-Duncan-McKean points from the Northern Plains. Furthermore, points from other sites in BC were found to be similar to another Northern Plain's diagnostic: Pelican Lake points.

Microblades were another technology shared by BC and the Northern Plains, although they were exceedingly rare on the Plains and somewhat more common in the

boreal forest. One site in particular with microblades was EdPk-1 near Calgary (Wormington and Forbis 1965:130 In Sanger 1967:192). These distinctive tools came in a variety of shapes and sizes, and some had unifacially-modified edges (Sanger 1967:191). The differences in microblade technology were associated with temporal periods and geographical regions, signifying that the spread of this technology was through group interactions or movements. Polished nephrite adzes were likewise a hallmark BC technology and were recovered from a few rare sites on the Northern Plains (Sanger 1967:192); nephrite adzes did not appear until after 4,500 BP in BC (Darwent 1998:22). The nephrite used to construct the adzes found in the Northern Plains was local to only BC.

Cobble Spall tools (CST's) from BC present another link between the Canadian Plains and BC, as there are similarities between them and Eldon unifaces. This similarity may not represent cultural interaction but rather a similar adaptive technological response to a particular problem; however, the former cannot be entirely ruled out.

Morphologically, these tools are almost identical, along with similarities of lithic material, dates, and site types. Although, while Eldon unifaces are known only from the Middle Period, CSTs seem to have been used throughout BC prehistory, particularly in the interior and have been recorded in ethnographies of the southern and northern interiors (Hayden et al. 1996b:29; Albright 1984:56). Notwithstanding, this is the closest similarity to Eldon unifaces found in researching this thesis. This section describes CST's, pebble tools and the use of a bipolar strategy to flake various artifact types such as microblades and pebbles. Similarity of function is addressed in later chapters. While the morphologies of these two artifacts are almost identical, this does not automatically mean that their function was too. Further, if the functions do match alongside their morphology, then it becomes even more interesting that one artifact continued to be used in one region but not the other. Why this is, is not addressed here but does suggest future avenues of research.

Geographical Region and Date

CST's have been recorded in archaeological sites along the BC coast and interior. Some of the coastal sites are the oldest recorded in BC, nonetheless North America (eg. Bear Cove site [Carlson 1979] and Namu [Fladmark 1982]). CST's were found alongside

pebble tools in these early assemblages. This was referred to as the Pebble Tool Tradition, or the Late Lithic Substage and dated to between 10,000 and 5,000 ya; CST's have also been found along the southern coast of Alaska, as at the Ground Hog Bay site (Ackerman et al. 1979:201). The Pebble Tool Tradition included both unifacially and bifacially chipped tools and was hallmarked by leaf-shaped and stemmed points, only found on the coast (Haley 1996). A similar strategy of bipolar percussion manufacturing was used for spall and pebble tools. During the Coastal Middle Period (Marpole phase) these and other flake tools disappeared, but they continued to be made and used in the interior (Grabert 1979; Fladmark 1982 and 1990; Hayden et al. 1996a; Hayden 1997; Rousseau 2004). In the interior, early ethnographers recorded CST's during late 19th and early 20th centuries (Rousseau 2004). The use of these tools was restricted to habitation sites of predominantly the southern and to a lesser extent, central interior BC (Hayden 2005).

One of the better-understood interior sites with spall tools was that of Keatley Creek (Figure 3.25). The Nesikep site also had spall tools, but it has fewer publications than Keatley Creek. CST's were rare because of their long shelf lives and "moderate-to-low processing volumes" as expressed by their frequency in the Keatley Creek assemblage: N=41, 0.7% of the total (Hayden et al. 1996b:33); a likely similarity with Eldon unifaces. Although these tools were curated, they were not likely transported because of their cumbersome size and weight; additionally, this is likely true for Eldon unifaces. CST's were only found at winter villages and fall mountain hunting camps. The tools were cached at the sites upon seasonal movement, again like Eldon unifaces at EgNp-63 and EgNq-18 (Hayden et al. 1996b:31). Seventy-six percent of the Keatley Creek site cached CST's were still usable. One of these caches from Housepit 7 revealed that they be considered *site furniture* similar to a stone anvil that would be used only at the site and not removed. The tools were found along only the eastern wall of housepit 7, whereas other tool forms were found on all but the southern wall (Hayden 2005:66). The wall space is also inferred to have acted as a storage area for other items, sometimes with sleeping platforms lying overtop (Hayden 2005:68). Out of interest, housepit 7 salmon remains were a mixture of ages, bespeaking a measure of wealth by the residents as older salmon were more valuable than younger salmon (Hayden 1997; Archer 2001).

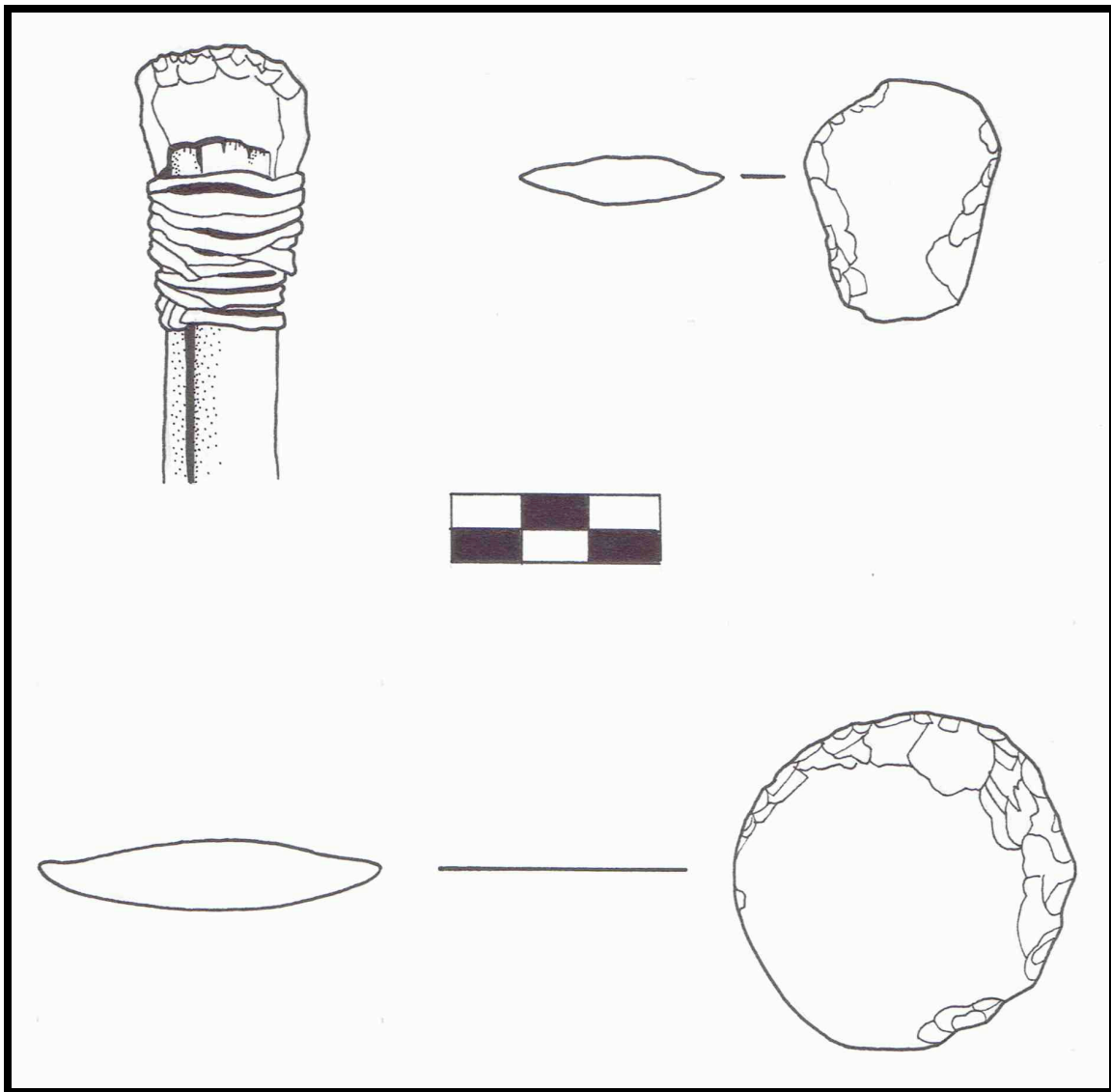


Figure 3.25 CSTs from Keatley Creek site. Above-left is a hafting method for a CST recorded by Teit in 1900 (redrawn from Hayden et al. 1996b:30).

Description

CST's from BC were made from large coarse-grained quartzite cobbles (Carlson 1979; Hayden et al. 1996b:29), although other similar lithic materials were less frequently used and a product of location like the usage of basalt cobbles by the Tahltan (Albright 1984). These were referred to as *robust* stone tools (Hayden et al. 1996b:32) although CST's from early coastal sites were quite small, averaging 7cm in diameter (Morin 2004:292; Rousseau 2004). Early coastal site CST's tended to be flat and oval, a product of a flake removed from the side of a cobble (Carlson 1979:188). Tool edges were convex and

unifacially flaked, although some were bifacially flaked and some not at all (Carlson 1979; Haley 1996; Morin 2004; Rousseau 2004). The ventral surface was completely covered by cortex (Rousseau 2004:26-27). Striking platforms were generally retained and characteristically broad (Carlson 1979:188). All of the above attributes are further true for Eldon unifaces.

The manufacture of CSTs began with the splitting of a large and round quartzite river cobble or boulder (Hayden et al. 1996b:31). The most effective method of detaching flakes from a cobble was through bipolar percussion, similar to the approach with Eldon unifaces (Carlson 1979). This was described as “a method or technological procedure for making the best possible use of an *extremely common raw material* to provide most of the day-to-day tool needs of the people” (Haley 1996:61, emphasis added). Cobbles were also one of the best raw materials available to create large flakes in BC. Cobbles were often found near river shores that would freeze during the winter months or could be collected from eroded till that would be obscured from fallen snow (Grabert 1979:165; Hayden et al. 1996b:31; Hayden 2005:59). Tools would be kept for multiple years or cobbles would be retrieved and stored for use during the warmer months (Hayden et al. 1996b:32). The storing and difficulty of obtaining cobbles during the winter is discussed in the next chapter for this likely was a consideration for Eldon unifaces.

Only hard-hammer percussors, through either a free-hand or bipolar technique, were used to knap (Haley 1996:60); again similar to Eldon unifaces. Borden (1968:61 in Haley 1996:51) wrote that “[the Pasika stoneworkers]...seem to have lacked the techniques required for flattening and thinning stone projectile points and knives of thin bifacial form” and that such a deficit of knowledge may have spread to the pebble tools as well. CST’s from the Cherry Point site, south of Vancouver and the Fraser River delta, were given this description, which was applicable to the construction of CST’s from other regions and time period:

“many show edge battering, with use flaking occurring bifacially and with some showing direct edge-on impact. Others seem to have been dressed nearly flat from the unifacial starting point and an edge angle of 60 degrees so that the worked surface is almost 90 degrees to the major axes. Flakes removed in final dressing of the implement are short with overlapping, step-like fracturing, so that a rasp-like surface is created. Some of these surfaces show use abrasion, others do not” (Grabert 1979:170).

Attributes of choppers and CSTs denoted that “the frequency of recycling was limited only by the thickness of the central mass of each particular cobble” (Haley 1996:60). These attributes were influenced by the natural shape of the cobblestone and also depended “on the desired outcome and the perceived potential of the particular parent body” (Haley 1996:60). The byproducts of the manufacturing of these chopper tools were likely recycled into other tool forms, resulting in few waste flakes or other debitage from tool manufacturing (Haley 1996:53). This is similar to Roe’s (2009) findings regarding Embarrass Bipoints although it is unclear if Eldon unifaces were also recycled.

Ethnographic data demonstrates CST’s from interior BC were hafted (Albright 1984; Hayden et al. 1996b), but research from early coastal sites shows they were held in the hand (Carlson 1979). Figure 3.26 shows a hafted Tahltan CST. Hafts required substantially more manufacturing time than the construction of the stone tool itself (Hayden et al. 1996b:31; Rousseau 2004). Although a measure of time was needed to make a handle, ethnographic accounts implied they were handed down over a number of generations (Albright 1984). Handles had two requirements: the binding had to be durable enough to withstand high pressure loads, and secondly, the handle needed to be big enough to accommodate the tool’s large size (Hayden et al. 1996b:31). The handle itself was very long, stout, and made from wood (Hayden et al. 1996b:31). A longer handle allowed for more pressure to be exerted upon a hide (Hayden et al. 1996b:32). Wear traces on the proximal halves of the tools is commonly observed and is a product of wear in the haft (Hayden et al. 1996b:32). In addition, modification to a spall tool’s lateral edges was done to aid hafting.

Function

The Pebble Tool Tradition tools, including CST’s, were perhaps used to pulp and rasp materials (Mitchell 1971:106 In Grabert 1979:171); based on the Cherry Point site assemblage. However, Teit and Albright in the early 1900’s in the central to southern interior of BC recorded that CST’s were used to “stretch hides in the tanning process” (Hayden et al. 1996b:29). Figure 3.27 depicts a CST used in processing hides by a

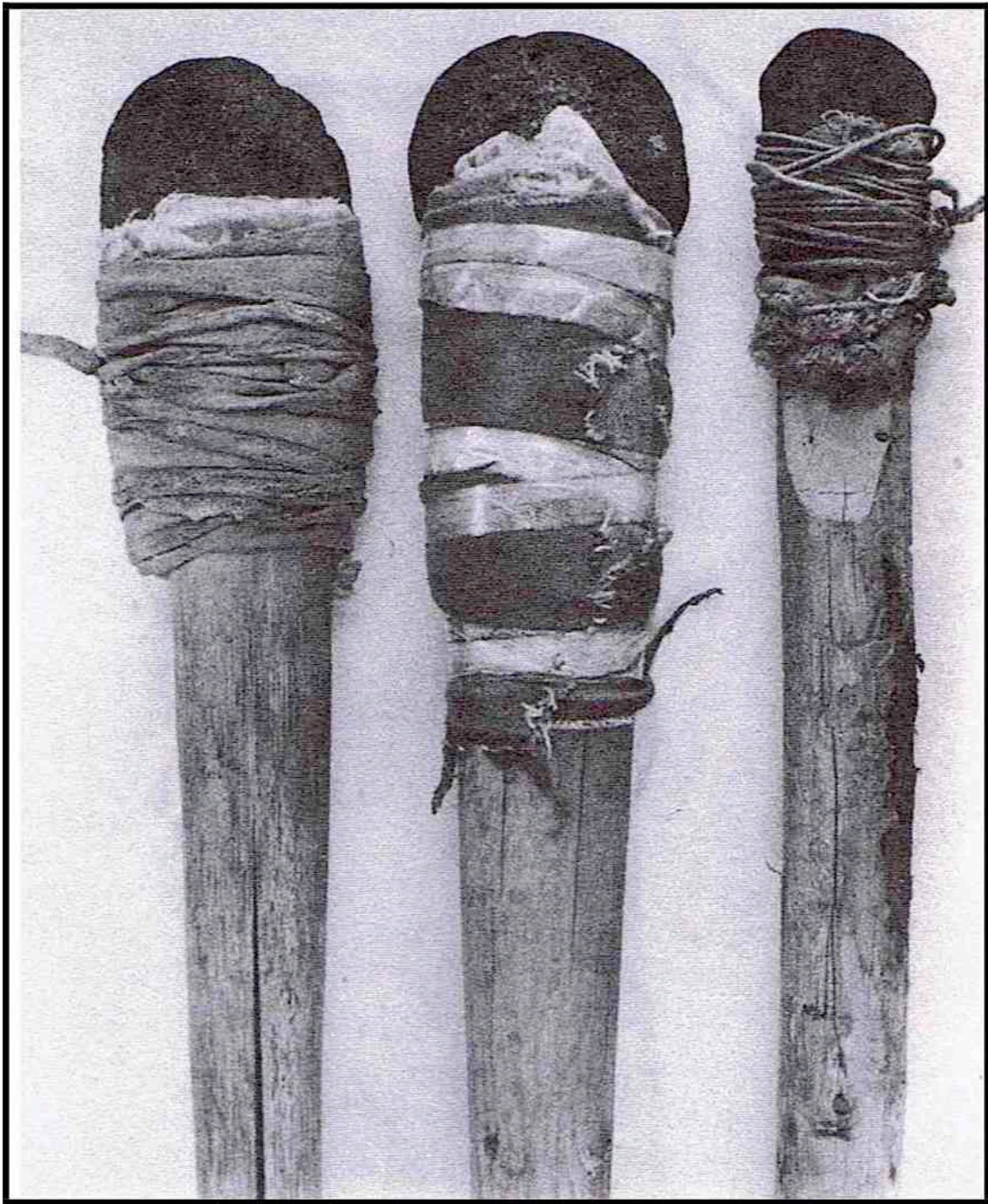


Figure 3.26 Tahltan hafted cobble spall tools (Albright 1980:56). Courtesy SFU Archeology Press.

Tahltan woman. Similarly, an ethnography of the Tahltan of north-interior BC indicates they used CST's to process hides (dressing stage), and also work wood (Albright 1984); these tools have a number of similarities to Eldon unifaces. For the hide working tools, a pebble is bipolarly split on an anvil. Such pebbles are "oval or elongated in shape...collected by women during the course of other procurement activities and kept until needed for manufacturing new tools" (Albright 1984:57). Flakes are removed with a hard hammer from the ventral surface, leaving the cortex on the dorsal side. The working edge is dull as sharper edges would rip the hide. In all, it takes about ten minutes to manufacture one of these tools. Following the activity, the tools are curated and handed down from mother to daughter, some with reputed ages of over 100 years. Woodworking adzes were given less attention in the Tahltan ethnography, but moreover shared similarities with Eldon unifaces. These adze blades were likewise made from splitting

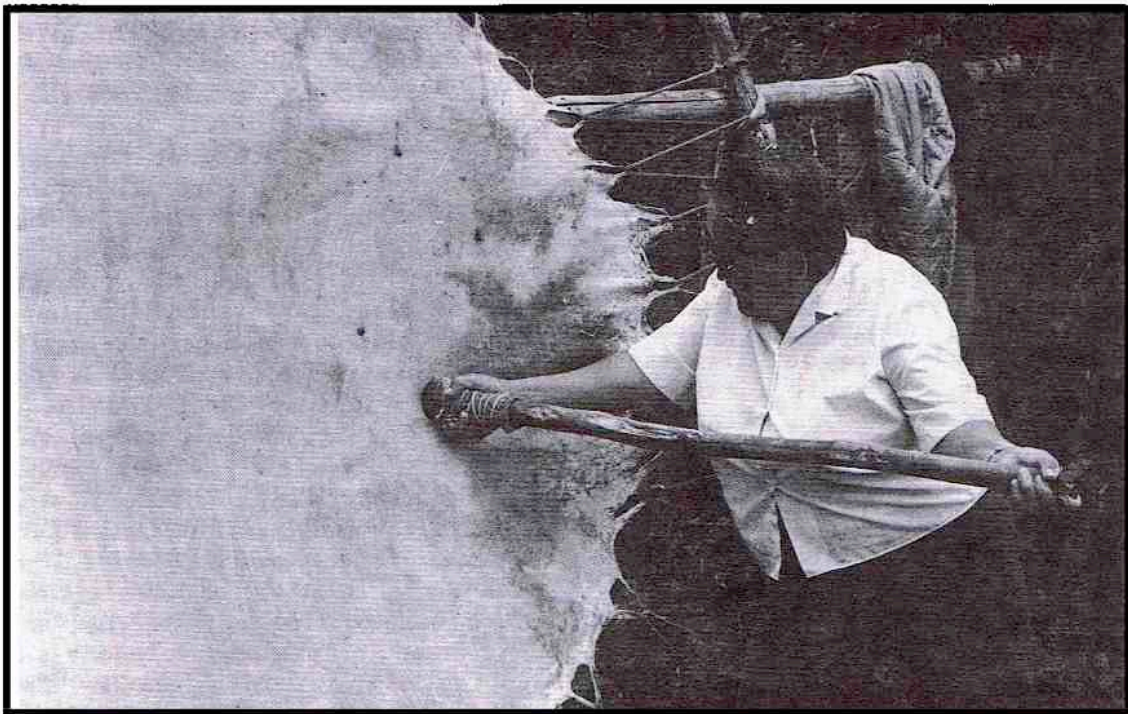


Figure 3.27 Tahltan cobble spall tool used for hide processing (Albright 1980:56). Courtesy SFU Archeology Press.

pebbles and then flaked with a hard hammer and pressure flaked with an antler tine. Following the flaking, a sandstone abrader was used to grind the edge. Presumably the cortex was left intact, although Albright (1984:68-69) does not specifically state this. Once complete, the adze was inserted into a curved wooden handle.

Recent studies reveal that these tools were also employed to process salmon (Morin 2004; Rousseau 2004; 26-27). This argument was made in reference to CST's of the Nesikep Tradition (7,000-4,500 BP) in the Canadian Plateau of BC. These tools were referred to as 'simple cobble /pebble choppers'

"which were struck from discoidal cobbles, and are commonly observed at many large fishing-related sites along major salmon-bearing rivers..."
"These simple quartzite spall tools are also formally suited for incising and parallel scoring through ribs and flesh to prepare fish sides for wind drying. Repeated beheading and parallel scoring dulls any stone tool edge fairly rapidly, but the ubiquity and abundance of discoidal quartzite cobbles and other suitable microcrystalline silicate lithic raw materials, and the low level of technological skill required to produce them, would have allowed these simple spall tools to be produced quickly and in large numbers for executing this difficult step of the fish cleaning process. This reduced the risk of breaking less durable and more 'precious' hafted bifacial blades, which were better suited to belly slitting and collaring" (Rousseau 2004:27).

CST's function were characterized as "high intensity, but sporadic and low-frequency" (Hayden et al. 1996b:29). Hayden (et al. 1996b:31) argued that spall tools, in particular large quartzite flakes were ideal for stretching hides. The working bit edges of these tools were most effective in working hides when they had dulled edges that could "grip slippery surfaces" and had "large, broad edges" so they can soften "large areas at once" (Hayden et al. 1996b:32). Once the edge had formed they would require little maintenance during use, as quartzite does not quickly degrade. Stretching skins likewise required considerable force applied by the tool to the hide in order to deconstruct lignin fibers. Quartzite does not also crumble as easily as other lithic materials (Hayden et al. 1996b:30). The goal was to not cut the hide while applying high pressures. Coarse-grained stones satisfied this duality because they did not cut the skins while additionally providing a stable material that would not snap under such strains. Better than other lithic materials, quartzite also removed the wet endoderm from the hide.

Due to the hardness of quartzite, wear traces were not commonly identified on CST's because quartzite wear only develops over a very long period of time (Hayden et al. 1996b:30). However, many of the pebble and spalls tools from the Cherry Point site had significant signs of wear along their distal edges (Grabert 1979:170). Furthermore, few of the CST's from the Keatley Creek site were found broken and the value of quartzite was indicated by the abundance of the material in the Keatley Creek site spall tool assemblage: 41.5% of the tools were made from quartzite, 19.5% trachydacite, 9.8% andesite, 2.9% olivine, 2.2% shale, and 22.9% indeterminate (Hayden et al. 1996b:31; Hayden 2005:135).

CST's were also recovered from the Maurer site near Agassiz in southwestern BC, inside a possible dwelling floor (Shaepe 2003:142). The site dated to 4,200 BP, belonging to the Eayem Phase of 5,500-3,500 BP (Shaepe 2003:150). It was argued that CST's were used to work hides and 'cobble core tools' were aligned with woodworking tasks; yet, the physical difference between these two tool forms was not elaborated upon (Shaepe 2003:143); the working of skins were referred to as a 'moderate to heavy' task (Shaepe 2003:145). A total of 13 spalls were recorded from the site, of which 9 were unmodified; one had an acute unifacial flaked edge, one had an obtuse unifacial flaked edge, one had an obtuse bifacial edge, and the other spall was not recorded in more detail (Shaepe 2003:144). Further to the spalls, there were also two unifacial pebble core tools, each with an acute edge and one with an obtuse edge.

A variety of functions have been assigned to CST's from the Port Hammond site in the BC lower mainland. These tools were assigned a vague task of 'food processing' (Rousseau et al. 2003:92). A radiocarbon date of 1,995 \pm 80 BP suggested the site was occupied during the Marpole phase that lasted between 2,500-1,500/1,100 BP (Rousseau et al. 2003:89).

3.5 Conclusion

This chapter described the archaeological sites with possible and confirmed Eldon uniface artifacts. These sites extend from western Saskatchewan to eastern Alberta. There was a possibility that these tools might also exist in adjacent regions, such as southwestern Manitoba, Montana and Idaho. Archaeologists from the University of Manitoba, the Manitoba Heritage Branch, and consulting archaeologists from Manitoba

were contacted. None of these archaeologists were familiar with Eldon unifaces. Archaeologists from Ontario were also contacted in regards to Eldon unifaces but again none were familiar with these artifacts.

The sites with Eldon unifaces that were analyzed during this thesis all shared important similarities. Important similarities were that the sites were located near water and wood resources, were all campsite /habitation areas, and those sites with associated dates belonged to the early-Middle Period of the Mummy Cave Series.

A brief synopsis was presented in this chapter of the early-Middle Period on the Canadian Plains. This synopsis focused on the types of stone tools used during this period. This list was not exhaustive and was complicated by the fact that few researchers discussed to any great length the role of unifacial stone tools. The climate and subsistence economies of this time period were also briefly outlined.

A brief description of tool technologies from Northeastern North America, Manitoba, and British Columbia were also discussed and compared to Eldon unifaces in this chapter. Few similarities can be drawn between Eldon unifaces and tools described from the Maritimes because the tool descriptions are so brief. Adzes from Manitoba shared similarities with Eldon unifaces. Commonly, the descriptions of these tools were nestled inside reports that focused on more general issues. Brownlee (1995) was the only author to solely tackle the subject, but unfortunately his report was preliminary and remains unpublished. Nonetheless, three types of adzes did share some similarities to Eldon unifaces. The bi-pointed adzes were similar to Corner Eldon unifaces in that both had two opposing working edges. Trihedral and chisel adzes also shared commonalities with Classic Eldon unifaces, but these similarities were limited and might represent flint knapping strategies that were shared by most tool-using societies and were not distinctive to one particular group. Three artifacts from EgNq-18 had some important differences from other Eldon unifaces and share some similarity to adzes in Manitoba.

Stone tools from British Columbia were the third group discussed in relation to Eldon unifaces. In British Columbia, the Nesikep site was mentioned for it was a likely indicator of group interaction between the Plains and Plateau region of the Northwest. CSTs at this site and others in the central to southern interior and southern coastal regions of British Columbia were very similar to Eldon unifaces in morphology and Chaine

Opératoire. Both CSTs and Eldon unifaces were constructed from bipolarly flaked quartzite cobble spalls. The artifacts additionally retained their cortex surface across the entirety (or close to) of the ventral face, with edge modification focused along the distal edge and less so on the proximal and lateral margins; again, these features are also argued for Eldon uniface construction and morphology. CSTs were furthermore hafted, which is true for Eldon unifaces. Another similarity between these tools was that CSTs were found at habitation sites, such as the Keatley Creek site where they were stored along the walls. The function of CSTs ranged considerably, but hide working seemed to be a common theme. Differences were also present in that Eldon unifaces are not known from past the Middle Period and there appeared to be more variability in their form, although, this might be due to the limited study of CSTs. As it currently stands, CSTs are only briefly considered in the literature and spoken of in groups and not individually; hence, this promotes a focus on generalities of CSTs. This was again another similarity in that the artifacts had been cached and curated. It is argued here that these similarities represent a similar technological adaptation to a given problem. The similarities in morphology and manufacturing are enlarged upon in the next chapter. The similarities of function are addressed in the last two chapters.

Chapter 4

Steps & Separations

No archaeologist is worth his salt... unless he makes an analogy or two in every monograph he writes.
Chang 1967:229

4.0 Introduction: How& What

This chapter discusses how Eldon unifaces were made based on their morphology, experimental re-creation and analogies. Construction is a three step process: obtaining the raw material, splitting the raw material to produce a blank or spall and modifying this into a useable tool, similar to Cobble Spall Tools from British Columbia. The theoretical frameworks used here are Design theory and Chaine Opératoire (or sequence models). These two frameworks are closely related and overlap. Design theory considers *constraints* involved in using and making artifacts. Conversely, sequence models consider *choices* and propose steps that were taken in manufacturing artifacts.

4.1 Design Theory

“When evidence is encountered which has no known analogs, it is incapable of interpretation. Such evidence may go unrecognized, may be ignored, or may fill the categories of ‘problematical objects’ or the ubiquitous ‘sacred paraphernalia’. Whatever its taxonomic and chronological value, these remains can only be assigned a morphological type” (Kleindienst and Watson 1956:75).

The usage of design theory fulfills the proclamation of the above quote by Kleindienst and Watson, but still utilizes analogies to show similar strategies in manufacturing. Design theory does more than discuss materials for it also provides inferences about the people who made and used materials. The following information sets the groundwork for a functional analysis of Eldon unifaces.

Design theory originated not in archaeology but in the fields of architecture and engineering (Odell 2001:79). Over 100 years-ago William Henry Holmes was one of the first archaeologists who used a form of Design theory (Andrefsky 1998:3), although it was not referred to as design theory until decades later when it was adopted by researchers in the field of architecture and engineering (Odell 2001:79). Holmes contended a systematic study of lithics that focused upon three areas of interest: stone

tools as diagnostics for particular time periods; changes in tool form and use over time; and analysis of how stone tools were used and made. Design theory focused upon Holmes' second and third points. Contemporary uses of Design Theory involve the study of an artifact's "morphology, size, raw material, production mode, functional efficiency, resharpening and tool use-life" (Rousseau 2004:6), along with broader issues of a tool's "reliability, maintainability, risk, mobility, versatility, and flexibility" (Hayden et al. 1996b:9). Through understanding these variables, artifact morphologies and assemblages can be better understood (Hayden et al. 1996b:9). An artifact's lithic material, functional requirements and overall use-history are further aspects that can explain variability among similar artifact types (Andrefsky 1998:154). This variability represents choices that were a direct product of human behavior (Driskell 1986:75). These choices are a product of constraints, which is the cornerstone idea in Design theory (Hayden et al. 1996b:10). Constraints involve solving a problem through technological means, the product being an artifact. In reality, this is a form of creating null-hypotheses for testing against artifacts. The null-hypothesis is a constraint that disallows an action or limits available options, and therefore the remaining options open to a group would be the possible answers to why an artifact was shaped in such a way or was used in such a way.

Design theory organizes artifacts by two aspects: *technological attributes* and *functional attributes* (Morin 2004). Technological attributes consist of the physical aspects of an artifact while the functional attributes involve using or replicating the use of the tool. While there is never a truly optimal solution to any problem and there are numerous ways of solving the same problem. Proponents of design theory argue for the importance of understanding the context of an artifact, for that may shed light on the *range of acceptability* in which a solution is chosen for dealing with certain problems (Morin 2004:284).

Design theory furthermore divides artifact life-histories into a number of segments: procurement of the raw material, manufacturing, use, modification, curation, discard, and finally retrieval (McBrearty et al. 1998:108). The discard segment represents those artifacts that became unwanted and are the culmination of the effects of manufacture, resharpening, and use (Jeffries 1990:8). Choices occur during each of these segments including discard (Rousseau 2004). Design theory considers why one choice

was picked over another and contrasts this with similar artifacts and the choices that were made for them. Such choices can promote a means of problem solving through *technological means* (Hayden et al. 1996b:10). Some have argued that these are solutions of efficiency where the most efficient tools were consciously or unconsciously sought (Plew and Woods 1985:223-4).

Table 4.1 Tool Constraints (modified from Morin 2004:299).

Table 4.1		
1. Temporal Constraints	2. Technological Constraints	3. Task Constraints
a. Production	a. Raw Material	a. Wood Working (?)
b. Resharpening	b. Skill /Training	b. Bison Processing (?)
c. Efficiency	c. Diversity of Uses	c. Hide Processing (?)
d. Time Available		d. Fish or Other Processing (?)

Choices in an artifact's life-history were the product of human behavior shaped by constraints (Driskell 1986:75). Possible constraints for artifacts on the Northern Plains are listed in Table 4.1 (after Morin 2004:299). In this table, temporal constraints refer to the amount of time it took to complete a task such as manufacturing a tool, hafting a tool, and maintaining the tool's edge while used. Technological constraints refer to the knowledge and skill required for constructing a stone tool. This scheme can be vague and subjective for it is based on experimentation of recreating a stone tool, but the technological constraint of working a particular raw material is less subjective. The final constraint is task constraint. This constraint was originally referenced to the tasks required in processing salmon in British Columbia, but can easily be transported into a discussion of Plains' tasks. From Table 4.1, many of the constraints are discussed in this chapter, such as 1.a, 1.b, 2.a, and 2.b. The others are discussed in the next two chapters.

4.2 Sequence Models of Eldon Unifaces

As explained above, Holmes' third point on stone artifacts was to gain a better understanding of how artifacts were constructed. Archaeologists have continued to be

interested in such an understanding underlined by the *Chaine Opératoire* concept as advocated by Francois Bordes some fifty years after Holmes (Driskell 1986; Andrefsky 1998:3). This section discusses an important component to Chaine Opératoire: experimental archaeology /flintknapping. The pursuit of this backbone to Chaine Opératoire explains the process of how to replicate an artifact. Such a discussion allows for the application of these ideas to further explaining Chaine Opératoire.

Experimental Archaeology /Flintknapping

Experimental archaeology recreates aspects of the past. This approach is important for it reconstructs past human behavior much like the direct analysis of artifacts (Driskell 1986; Andrefsky 1998:3; Stout 2002). L.S. Vygotsky (1976:20-23 In Stout 2002), a Soviet psychologist, noted “human tool behavior involves a close integration of cognitive and symbolic processes with *practical intelligence* or *technical thinking*”. Flintknapping is a type of experimental archaeology also called *realistic* or *replication study*; other examples of experimental studies include using stone and metal axes to fell trees (Mathieu and Meyer 1997) and voyaging by traditional means such as dog sled (Dick 2001). Johnson (1991:79) defined flintknapping as “the process of applying force to a suitable stone in such a way as to sever it or remove a spall”. Although archaeologists understood the practice of flintknapping more than a hundred years ago, Bordes, Crabtree, and Tixier argued in the mid-twentieth Century for a more systematic approach to flintknapping where the process of recreating a stone tool was thoroughly recorded (Carr and Bradbury 2004:24). Such an approach was considered *scientific*. A product of this research was the recognition that a life cycle existed for stone tools and their forms were the product of reshaping or sharpening earlier versions (Carr and Bradbury 2004:23).

Similar to experimental studies such as flintknapping, Tilley (2004) discussed walking through a landscape. Walking weaves our lives through a landscape and forces part of our life-histories into this landscape that is then created and transmuted through the lived perceptions. Would flintknapping be any different than walking? If not, then Chaine Opératoire studies hold the potential of re-enacting lived perceptions.

There are two ways to illustrate how an artifact was made. The first is to study the arrangement of flake scars to understand which piece was removed first, and to

understand how that shape came to be. This approach was used in this thesis. The second approach, refit analysis, is where flakes are physically pieced back together (Larson and Kornfeld 1997; Gowlett et al. 2005). This second approach was not used here, as only the tools were available for analysis and not the associated debitage.

Sequence Models /Chaine Opératoire

Choices in flintknapping are an expression of culture (Grace 1996:219). Such choices reflect an operation system of past societies in which decisions were made on how to circumvent a particular problem (Bleed 2001:102). Ethnoarchaeological studies submit a pattern (reduction sequence) was followed in creating stone tools and a flintknapper's experience was drawn upon to solve unanticipated problems that arose during the flintknapping steps or sequence (Stout 2002:704). The study of these sequences is called *Chaine Opératoire*. The results of *Chaine Opératoire* studies were anticipated by Tylor, who wrote that intelligence was found in the *hands* (In Ingold 2004:318-9), and so what the hands created is a manifestation of transferred intelligence. Similarly, Marx argued that the intelligently driven hand made tools and therefore tools were a manifestation of our intelligence: "power of knowledge, objectified" (Ingold 2004:332). This had been linked to optimizing theory, where it was only the most efficient choices that were made. However, this reduces human behavior to simplistic and deterministic elements that portrays people as automatons. This is anything but the case and is one of the major criticisms against this line of thought. A second major criticism is that optimizing theory "is incapable of explaining behavior beyond a subsistence level. As cultural complexity increases the most optimal decision on an economic level may not be the best choice on a social level" (Darwent 1998:31).

Chaine Opératoire is the archaeological conceptual tool used not only to understand how stone tools were created, but also how they were used, where and how their raw material was procured, and how they became discarded (De Bie 1998:91 In Odell 2001:80). Reduction sequences are integral to, but not the only part of, *Chaine Opératoire* studies (Driskell 1986). It is a holistic study of artifacts, unlike Design theory that is narrower in focus. Within this conceptual tool is the goal to more specifically address questions of human behavior from a perspective that is otherwise not available within archaeology (Odell 2001).

The choices made and not made in creating and using an artifact can be understood through analyzing its life-history. A cognitive and evolutionary shaped study is sometimes used to understand this life-history, where the choices that a person made to create or modify a tool are malleable due to unforeseen circumstances that arise during the creation of a tool, but the ultimate goal remains the same (Gowlett 1982:101; Bleed 2001:121). A more constrictive view is the *teleological model* where decisions in how a tool is made follow a set pattern that is immutable to change (Bleed 2001:121). When graphically represented, an *evolutionary model* displays branches in the decision making process while the teleological model suggests linearity; Eldon unifaces ascribe to the former. Another difference between these two models is that “teleological models point us toward ideal patterns and the emic study of cultural systems whereas evolutionary models help us understand real behavior from a perspective that would have to be called etic” (Bleed 2001:121). A common thread in the models is that choices form a string or chain that is subordinate to an ultimate goal. However, ethnoarchaeological studies indicated that traditional flintknapping did not happen quite this way for there may be multiple goals separated in time during the life history of an artifact (Hayden 1987). For instance a tool might undergo morphological alterations throughout its life that were not originally anticipated when the tool was created; for example, a projectile point becomes a scraper (eg. Frison 1968). An archaeologist only sees the final result of an artifact’s form; the scraper and not the projectile point (Odell 2003). Experimental studies such as flint knapping tied with *Chaine Opératoire* can provide clues to what these previous artifact morphologies were.

Chaine Opératoire studies have been used differently in separate regions of the world. Of particular interest are the usages in Japan, France, and North America. In Japan *Chaine Opératoire* has been used to analyze reduction sequences of Paleolithic microblades (Bleed 2001:102-105). *Chaine Opératoire* is termed *Giho* and is characterized by commonsensical arguments. Reduction sequences are highly structured and thought of as routines, being similar to ideas of *habitus* (eg. Bordieu 1977). *Giho* is commonly supported by associated refit and replication studies to strengthen the proposed arguments. The drawbacks to *Giho* are that it is a normative approach (Bleed

2001:104) and suffers from internal biases since aspects of modern Japanese culture are injected into the interpretations of Paleolithic Japan.

The French approach has a larger scope than the Japanese, where the entirety of an artifact's use-life is considered (Bleed 2001:105-108). In examining site assemblages, refit analysis has been conjoined to *Chaine Opératoire* to isolate where tools were made versus used. This has sometimes shown *fragmentation in time and place* for the making and using of tools (Gowlett et al. 2005). Furthermore, unlike the Japanese variant the French approach focuses more on the end result of a system's process than the actual mechanics of the process. This is likely a product of the French school of anthropological thought as influenced by the works of Marleau-Pontey (2002) and Foucault (2002). Artifacts are engaged through forming typologies querying the role of agency in both artifacts and actors, and in questioning the "ideational aspects of material systems" as a whole (Bleed 2001:108).

In North America, the name *Sequence Model* is commonly used in place of *Chaine Opératoire* (Bleed 2001:108-114). Sequence models began with Crabtree, who was influenced by his exposure to *Chaine Opératoire* studies in France (Kuhn 1992a:116). The transportation of ideas married well to Schiffer's emerging ideas on Behavioral Theory (Schiffer 1976; Shott 1998:311), which is separate from the French interest in behavior and cognition (Bleed 2001). For Schiffer, sequence models offered a way of discussing the sequence of steps that were involved in the creation and disposal of artifacts. Schiffer brought these steps further through his discussion of *transforms* in questioning the alterations to artifacts as they entered the archaeological record (Shott 1998:311), which was in relation to understanding an artifact's use-history.

The Americanist Behavioral model also brought forward evolutionary theory in discovering variation in human behavior, where the most optimal solution was set out and then queried against the the archaeological record (Kuhn 2004:562). Optimal solutions were proposed not as facts, but rather as possibilities in light of what actually occurred, and it was recognized that optimal solutions rarely occurred in human activities; Kuhn (2004:563) wrote that "we stand to learn more when the models fail to account for what people do or did as we do when they succeed". In fact, optimality is viewed as detrimental since optimality at one job would entail the reduction of efficiency in another

job: a balancing act. These variations can be understood as the steps taken at the outset or original manufacturing of a cultural material, and at how it was modified through its use(s), and finally in the way it became part of the archaeological record. Specifically this aim was to “highlight the advantages and drawbacks of different behavioral alternatives, and these trade-offs would apply regardless of whether the behavior in question was biologically determined or the result of human choice” (Kuhn 2004:562).

A benefit to using sequence models is that it focuses on the individual artifact. This was done in this thesis by discussing each artifact individually for its own unique attributes relating to both morphology and usewear. Usewear focuses on individual artifacts too as only one artifact at a time can be studied. The results of an analysis of multiple artifacts using sequence models and usewear approaches can then be interpreted using Design theory as this considers the constraints that influenced a tool’s manufacturing and use. The considered constraints can be expanded and grounded in cultural ideas by the use of Landscape theory. This research strategy begins with small questions and works its way up to larger, more complex questions. Such a strategy is employed in this chapter.

4.3 Manufacturing Steps of Eldon Unifaces

A component to this thesis’ project entailed the experimental recreation of Eldon unifaces but it should be mentioned at the outset that the author is not a highly skilled flintknapper. As is discussed below, quartzite is a difficult lithic material to work for experienced flintknappers and so was especially difficult for the author. Nonetheless, experiments were carried forth but with the aim of gaining an understanding of the processes that may have been involved in creating these tools. In addition, of particular note is that much of this experimentation was conducted with the goal of understanding how to remove flakes from a quartzite cobble using a bipolar technique, whereby the struck flake would resemble the overall shape of Eldon uniface artifacts, more so than the further refining of the flake to duplicate an Eldon uniface artifact. The point of this was that it was believed that the most challenging aspect of making an Eldon uniface was in bipolarly flaking quartzite cobbles, as many of the Eldon uniface artifacts have fairly simple edge modification.

4.3.1 Raw Material Acquisition: Characterization of Quartzite

Raw material is a constraint for it may or may not be found in abundance across a landscape, be readily accessible, or it may require specific technologies or skills to flake. Highly valued stone materials were those that could be knapped in a predictable fashion (Andrefsky 1998:23). These materials should ideally be fairly *brittle*, *homogenous* and *isotropic* (Kuhn 1992b:187; Andrefsky 1998:23). Although brittleness is a favorable attribute it additionally reduces the shelf-life of tools as the edges wear at a high rate (Kuhn 1992b:187). This can produce a balancing act of choosing brittle but not too brittle stone. Another constraint is that not all stone materials are equally available. High-quality non-local materials on the Northern Plains, for instance, were traded into the region. These included brittle chalcedonies and obsidians. These would be less common than local materials and therefore not as frequently used (Wright 2006:135). In addition, it is important to remember that the Eldon unifaces found at the HhOv sites were in a region that is predominantly known for its usage of BRS for tool construction. The choice to make the Eldon unifaces from quartzite when the vast majority of other tool forms were made from BRS is striking and emphasizes the importance that quartzite had as an Eldon uniface material. Nonetheless, what was the advantage of using quartzite over other stone materials? This question suggests disadvantages in stone materials other than quartzite and indicates benefits in choosing quartzite.

Wright (2006:445) defined quartzite as “a metamorphized sandstone that fractures in a conchoidal manner and, thus, can be chipped into tools”. Eldon unifaces were constructed from quartzites that are neither brittle nor homogenous. Quartzites are accessible across the Northern Plains in glacial tills and along riverbanks in the form of rounded cobbles that measure 64-256 mm in length; pebbles average 64 mm in length (Johnson 1991 and 1998). Figures 6.1 and 6.2 are photographs of naturally eroding Rocky Mountain quartzite cobbles from southwestern Saskatchewan. Quartzite also has a long history of use on the Northern Plains, extending through some 10,000 years. Quartzites are not all the same and each type can be easier or more difficult to flake. Identifying different types of quartzite can be problematic though, as there is little information on differentiating quartzites (Larson and Kornfeld 1997:5), a product of there being no commercial value in this stone (Johnson 1998:5).



Figure 4.1 Naturally eroding quartzite cobbles in southwestern Saskatchewan near the Cypress Hills (photograph by author).

The stone used for Eldon unifaces varies among brown, black, grey, blue, red, green and white colours. The predominant color is brown, or various shades thereof. The colors of Eldon unifaces are listed in Table 4.2, where the colors are arranged by material type and by external and internal colors. The colors were then recorded for the type of Eldon uniface and the gross location (separated by province). The types are listed as numbers 1-4: 1 Classic Eldon, 2 Angled Eldon, 3 Side Eldon, 4 Amorphous Eldon. The

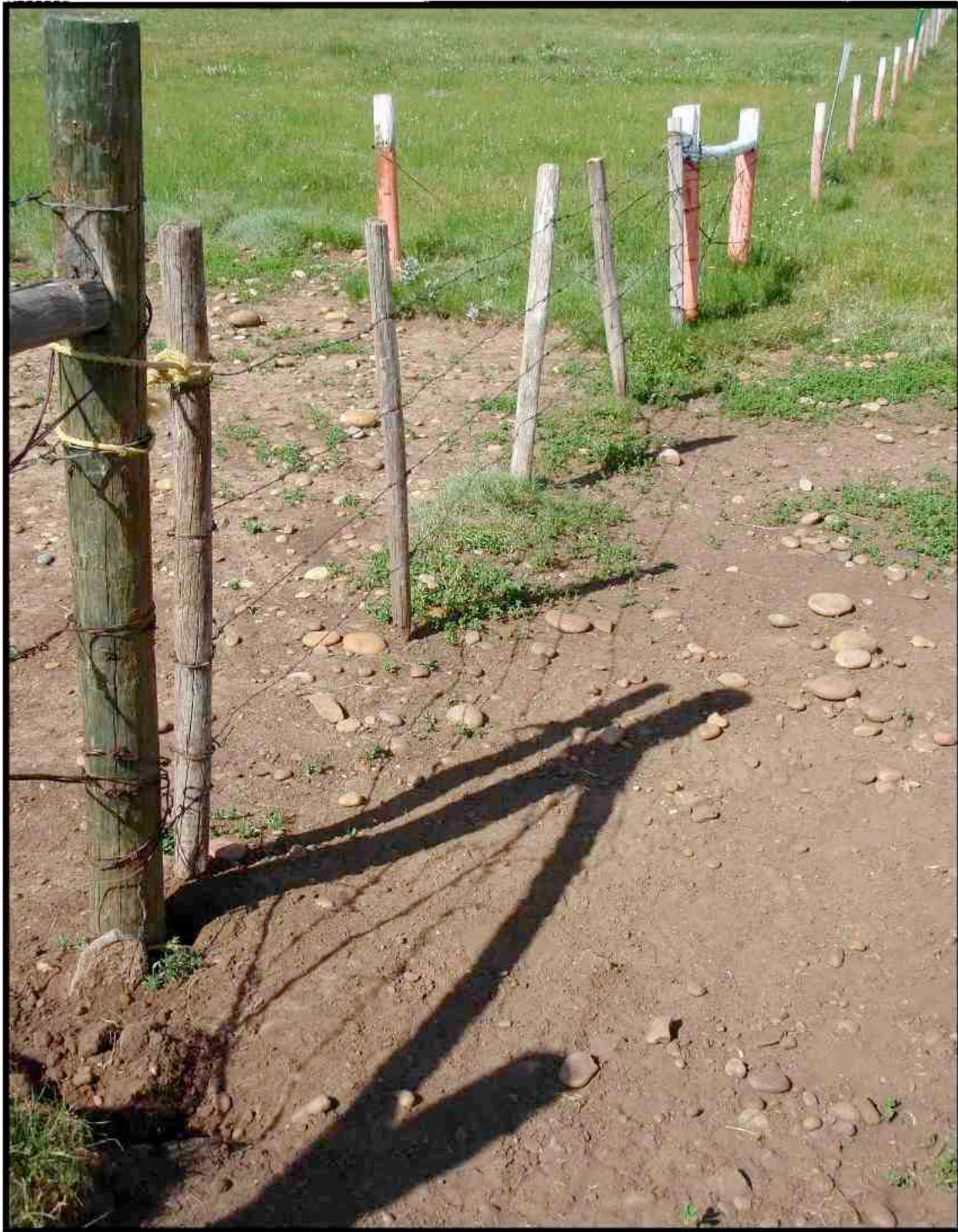


Figure 4.2 Quartzite cobbles near surface that have eroded out along fence line in southwestern Saskatchewan, near Cypress Hills (photograph by author).

colors were recorded with a Munsel chart and the colors were then simplified for this table. Very few of these stones had banded coloring and those with multiple listed colors were specimens with colors that shaded into one another. It is uncertain if any color was culturally preferred. For geographical differences, the only notable difference was for artifacts with both yellow-brown inner and outer surfaces. There were 16 from Saskatchewan sites but none from Alberta. Yellow-brown quartzite cobbles are exceedingly common in southwestern Saskatchewan and so this difference is evidently a product of a natural constraint as opposed to a cultural one.

Fine to coarse-grain Rocky Mountain quartzite was commonly used for Eldon unifaces. In comparison to other lithic materials, this is a very hard stone (Johnson 1998:13). This hardness is demonstrated in the MOH's scale of hardness (Table 4.3). Rocky Mountain quartzite is defined as a metamorphic stone characterized by its naturally round shape with *finger nail* impressions on the natural, cortical surface (Johnson 1993 and 1998). The colors range from tan, white, purple, and mauve, to a banding of these colors (Johnson 1993). The cobbles were deposited through "swift fluvial transport" a result of melting glaciers, which may have created the characteristic finger nail impressions (impact scars) (Johnson 1993 and 1998:10). These finger nail impressions appear to be partial hertzian cones that were formed as the cobbles were repeatedly tumbled through rocky riverbeds. The cobbles originated within Tertiary deposits in southwestern Saskatchewan (Johnson 1993); this is the same location for Eldon unifaces in Saskatchewan.

Rocky Mountain quartzites have a massive structure (Johnson 1993). Under a microscope, Johnson (1998) observed individual sand grains in thin slices of Rocky Mountain quartzite. He reasoned the stone developed through sedimentary formation followed by metamorphism (Johnson 1998:31). Metamorphic stones can repeatedly undergo metamorphosis. Within the earth, metamorphic stones are produced under conditions of great heat and pressure. This results in either a foliated or nonfoliated metamorphic stone. Foliated metamorphic rocks are stones with platy minerals arranged in a parallel pattern or that have a planar structure (Andrefsky 1998:54). Similar to sedimentary stones, foliated stones have a layered appearance. Nonfoliated stones on the

Table 4.2 Compilation of recorded colors for Eldon unifaces.

Table 4.2			Type									
			1		2		3		4			
			SK	AB	SK	AB	SK	AB	SK	AB		
Material Type	Dorsal Colour	Ventral Colour									Total by Specific Type	Total by General Color
Siltstone	Black	Black	1		1						2	Black:6
Siltstone	Black - Olive green marbled	Black	1								1	
quartzite	Black - blue - some red	light blue		1							1	
fine-grained quartzite	Dark Grey	Black		1							1	
fine-grained quartzite	Dark Grey with some yellow patches	Black	1								1	
RMQ*	Light Grey	Light Grey & Yellow	2								2	Grey:12
Fine Grained Quartzite	Grey	Light Blue-Grey			1						1	
RMQ	Grey	Brown	2	2			1		1		6	
Quartzite	Grey	Red		1							1	
Fine Grained Quartzite	Greyish Brown	Light Brown					1				1	
RMQ	Light Grey & Pinkish Grey	light Brown	1								1	Blue: 23
Chert	White - Blue-grey	Black	1								1	
RMQ	Light blue Grey & Yellow	Light blue Grey	2								2	
RMQ	Light blue Grey	Light blue Grey	4	3					1		8	
Fine Grained Quartzite	Light blue Grey	Brownish Yellow	1	2							3	
Medium Grained Quartzite	Light blue Grey	Pink	2								2	
Medium Grained Quartzite	blue Grey	light Brown	1	1							2	
Medium Grained Quartzite	blue Grey	Light Olive Brown		1							1	
Fine Grained Quartzite	Dark Blusish Grey	Black			1						1	
Medium Grained Quartzite	Dark blue Grey	Grey, with blue tinges	1	1							2	

RMQ	blue Grey & Light yellow Brown	Light Brown & Green Grey	1									1	
RMQ	White center-Brown	Tan	2	1	1							4	Brown: 32
RMQ	yellow Brown	yellow Brown	16		2					2		20	
RMQ	yellow Brown	Light Brownish Grey	4		1		1	1	1			8	
RMQ	Green Grey	Light Brown	2		2					1		5	Green: 8
RMQ	Green Gray	Green Gray	2									2	
Quartzite	Green	Dark Green				1						1	
Fine-Medium grained quartzite	Pink	Light Grey		1								1	Red: 15
RMQ	red Grey, with Dark red Grey Banding	red Grey, with Dark red Grey Banding	1									1	
Fine Grained Quartzite	Dark red Brown	Pinkish Grey	1									1	
Fine Grained Quartzite	red Grey & yellow	Light Green Grey	1									1	
RMQ	red Brown	Brown	1									1	
Fine Grained Quartzite	Light Red	Light Red	1							1		2	
Medium - Fine Grained Quartzite	Light Red	red Brown	1	1								2	
RMQ	Light Red	Light red Grey	1									1	
RMQ	Light Red	Light Green Grey		1								1	
fine-grained quartzite	Maroon - red	Maroon - red	2							1		3	
Siltstone	Maroon - red	Maroon - red			1							1	
RMQ	White - Grey	Grey-tan	1									1	White: 3
Medium Grained Quartzite	White & Yellow	Light Grey	1									1	
Fine Grained Quartzite	White, with canary yellow stripes	Light Red	1									1	

*RMQ=Rocky Mountain Quartzite.

other hand are massive, structureless and frequently formed of one mineral (Andrefsky 1998). They also have “only one structure that...consists of elongated or deformed grains” (Andrefsky 1998:54).

Table 4.3 MOHs Scale

Table 4.3	
1. Talc	6. Orthoclase
2. Gypsum	7. Quartz
3. Calcite	8. Topaz
4. Fluorite	9. Corundum
5. Apatite	10. Diamond

Metamorphic quartzites (metaquartzites) tend to be incredibly hard because they are primarily composed of quartz and are the product of deformed sandstones (Andrefsky 1998). The deformation of the sandstone results in interlocked quartz grains. When metaquartzites are broken, the breaks go through the conjoined quartz crystals unlike sandstones where the force of the break travels around the crystals (Johnson 1998:6). Further, recognition of grain sizes in metaquartzites (fine versus coarse-grain) is a way of differentiating metaquartzites. Grain size also influences a stone’s knappability and useability (Andrefsky 1998). Stones can additionally be differentiated according to their chemistry. Rocky Mountain Quartzite consists of over 98% silica and its “minor elements are F, Ti, Al, Fe, Na, Ca, Mg, K, and Ba” along with trace elements as indicated by ICP /AA chemical analysis tests (Johnson 1998:30). Trace elements are indicative of where the quartzite originally formed (Long et al. 2002) and indicates that they could be used to differentiate different types of quartzites and source such types.

Athabasca quartzite was also used for Eldon unifaces. This material is very similar to Rocky Mountain quartzite in color and structure, but lacks the afore mentioned fingernail impressions on the cortex surface (Johnson 1993). Another difference is that Athabasca quartzite tends to be coarser-grained and cobbles have angular ends, which aid flaking the cobbles.

Advantages & Disadvantages: Constraints

In Darwent’s (1998:1) study of nephrite adze blades in British Columbia (BC), he set out to “evaluate the costs and benefits involved in manufacturing and using implements made

of nephrite compared to those for other stone materials available for woodworking in the British Columbia interior”. Taking this approach for Rocky Mountain Quartzite, what was the cost and benefit of this material? Quartzite is easy to obtain and is a very hard material. Hard lithics are useful for they are more efficient than brittle materials in processing hard materials such as bone or wood. Tool edges do not dull as quickly as those of tools made from softer and more brittle materials. This reduces time spent on resharpening a tool’s edges and provides a longer use-life for the tool. The downside is that harder materials are more difficult to flake and the removal of flakes does not always occur in a predictable fashion.

Nephrite is one of the toughest lithic materials available in BC and was chosen in favor of other lithic materials to shape wood (Darwent 1998:1). Quartzite in the Northern Plains is similar to nephrite in this regard for it is hard and readily available. This relationship denotes that the choice of quartzite was additionally related to the task that it was used for. Also like quartzite, nephrite is difficult to shape because of its toughness. However, unlike quartzite, nephrite was polished, providing a highly regarded aesthetic quality.

Generally in stone using Prehistoric societies, expedient tools were made of low quality materials and formal tools were made of higher quality materials (Berman et al. 1999). Eldon unifaces are formal tools; however, is quartzite a high quality material? As analogy, Northern Plains points were constructed of both fine and low quality lithic materials (Pyszczyk 2003:60). Points of low quality materials like quartzite were not as well constructed as points of finer materials. This implies that at least for projectile points, quartzite was used not out of task or cultural constraints but rather resource constraints where people used what was afforded to them by their landscape and not out of choice. Durable materials like quartzite were additionally resharpened less often than other materials (Hayden et al. 1996b:26-27), hence “implement replacement rates” were minimized (Rousseau 2004:15). This resulted in a longer maintenance and use of tools made of hard materials and “because of their specialized nature and resharpening requirements...they were probably most often produced near quarry sites, since a large proportion of the core reduction debris would not be suitable for making them” (Hayden

et al. 1996b:26-27). The edges of tools made from softer stone, like basalt, dull and damage faster than harder materials, hence have a shorter life-span than quartzite tools.

Another constraint dwells in how quartzite is a common material in the Northern Plains, but is hidden under the ice and snow during the colder months. The material's reduced accessibility during colder months likely encouraged people to obtain their lithic materials during warmer periods; in particular, lithic resources from riverbanks would be greatly affected by this (Hayden 1979; McCullough 1982). In addition, stone becomes increasingly brittle as the temperature drops (Guthrie 1983 in Ackerman 2007:168), perhaps introducing difficulties in knapping stone. Raw materials for Eldon unifaces, were, therefore, likely collected and cached during these warmer months.

Control & Meaning

In Irian Jaya lithic sources were owned by individuals and passed down hereditary lines (Stout 2002:700-702). A head flintknapper controlled the flow of resources. This person received their position through their flintknapping skill and their personal attributes, such as charisma. These restricted materials were recycled more often than other materials. Ownership of raw materials was strictly guarded in the Irian Jaya case; for example, the head flint knapper held the right to kill someone who took items without permission (Stout 2002). A looser form of control also existed in some parts of the same region where anyone could obtain raw materials. Lithic material was often given to an expert flintknapper who transformed the stone into a tool in exchange for food. Similarly, individuals paid to access raw stone material in the Maya Highlands (Hayden and Nelson 1981:893). Rare and precious materials with less physical access such as volcanic glasses had stronger social controls on their acquisition. For both Irian Jaya and the Maya descendents, strict ownership made stone tools prestigious and valuable by artificially restricting the tools' availability (Hayden and Canon 1984; Hayden 1987).

Lithic materials were difficult to obtain in the Bahamas. As a result, a stone tool was used for multiple tasks and there was an increase in rejuvenation and recycling of that tool (Berman et al. 1999). Assemblages comprised of few lithic material types indicated the presence of a specialist strategy in obtaining and using lithic resources (Brantingham 2003:488). The correlation in physical restrictions may furthermore occur in instances of artificial restrictions such as those discussed above in the Maya Highlands

and Irian Jaya. If this correlation is true for other parts of the world, then the inverse of the correlation should apply to quartzite on the Northern Plains for it is readily accessible. A specialist strategy, coupled with the idea that fewer functions and less tool rejuvenation and recycling are associated with commonplace lithic materials, might characterize Eldon unifaces.

The Goma of Ethiopia presents a scenario that differs considerably from the above examples for there is no ownership of resources (Weedman 2006:199). This is an example where there are neither physical nor artificial restrictions. Instead, Goma hideworkers travel as a group to obtain raw stone material but use the resources individually. Once suitable materials are located they are knapped into a general preform shape prior to returning. The final shaping of the material occurs around a hearth at the settlement; however, the hide scraping activity occurs inside a dwelling. The majority of the knapping debris is collected and deposited in specific areas away from the settlement or place of children's play.

Closer to the Eldon uniface study area, Tahltan women collected and used lithic resources freely (Albright 1984). In the Goma example the flake stone assemblage should be similar to the Bahamas, Irian Jaya, and Maya Highlands assemblages except in the distribution of lithic materials within a site. For the Goma, lithic materials might only be associated with task areas but then again many people could occupy these areas. For Eldon unifaces, such a difference cannot be tested as there is insufficient information regarding the spatial distribution of the artifacts. Regardless, the Gros Ventres organized their tasks in a particular way that may have also been true for the gathering of lithic resources. This task organization is similar to the above examples where men were responsible for gathering the primary goods that the women manufactured (Flannery 1953:69). Tasks were commonly performed in groups although separated upon gender lines. Such a strategy as imposed in hunting but may have also occurred in stone tool making and gathering of other resources. For instance, Flannery (1953:69) wrote that "an individual was restrained from selfishly hunting alone and scattering the herd on which his fellows were depending". However, "once the chase started, each man was on his own and had the right of disposal over whatever game he killed" (Flannery 1953:69). In reference to stone then, perhaps the raw material was gathered communally but the

making and retaining of formed tools was individualistic. Additionally, support of communal gathering of stone in North America comes from the journals of Kohl (1956:282-283) during the mid-19th Century near Lake Superior. This is an account of how aboriginal groups quarried dark soft stones without requiring the permission of anyone else in that group. The stone was particularly used for constructing pipe-bowls. Further, this area was used by many different groups and is an area where no blood was shed as the stone was used “for their calumets of peace” (Kohl 1956:283).

4.3.2 Flaking /Splitting Cobbles

A *predetermined pattern* existed for the construction of Eldon uniface. Presumably, such a pattern could change and was not deterministic (Bleed 2001:120). In the case of Eldon uniface, this pattern is separated into four steps: obtaining raw materials, flaking /splitting cobbles, edge modification, and edge resharpening. As discussed above, the first step to manufacturing an Eldon uniface was to obtain the lithic raw material. The second step was to split the cobble. There are three methods offered here for how such cobbles can be flaked: free-hand technique, fire broken rock (FBR) technique, and the bipolar technique. It is argued that a free-hand technique was not used and the FBR technique may or may not have been used for Eldon uniface construction. The third technique, bipolar, is the most likely technique.

Eldon uniface size is a reflection of the natural cobble’s size, which was the size of a fist or larger, except in the case of the Gowen assemblage. Identifying how a cobble was flaked is important for it influences the shape of a flake and the final shape of the tool (Kuhn 1990 and 1992a:125; Hiscock and Clarkson 2005). Dibble (In Hiscock and Clarkson 2005) argued that the original size of a preform could be deduced by measuring the artifact’s thickness and platform area to reconstruct the original ventral surface area. The difference between this original and represented surface area reflects the amount of material loss, and hence retouch. Kuhn and Shott (In Hiscock and Clarkson 2005) disagreed and argued that core size effects flake size independently of platform size.

Free-Hand Technique

Free-hand percussion is a very simple method for it requires only two things: a core and a hammer. In this method one hand cradles the stone and the other holds a hammer made of

antler, wood, or stone. The hand absorbs the shock of striking the core or preform, along with directing the force of the blow (Stout 2002:698-699). The holding of the stone moreover increases the aim of striking. The arm with the hammer moves in an arc and strikes the top of the larger core. The force of the impact moves and exits through the core and results in flake removal, sometimes referred to as a spall flake or cortical flake. Specifically for a flake to be removed from its parent core, there needs to be enough force to “overcome the inherent tensile strength of the material” (Johnson 1999:82). Lithics like that of quartzite, have a high tensile strength and require a force relative to this strength to flake; which illustrates a problem in the free-hand technique for flaking quartzite cobbles as it does not produce enough force.

Novice flintknappers tend to strike a core multiple times, failing to detach a flake and often produce multiple step terminations (*stacking*) (Shelley 1999:188). In Figure 4.3, the left image is of an experimental quartzite core. The experimental core was struck



Figure 4.3 Stepped scars along a core's platform from incorrect striking.

both via a free-hand and bipolar method without the aid of a brace. The image to the right is the ventral surface of an experimentally knapped flake from a chert core struck via a free-hand technique. The platform at the top has multiple step terminations similar to that of the quartzite core). This was observed in the author's own experiments when initially attempting to flake a cobble. Some of the artifacts studied here also have signs of multiple strikes on the cortical surface, but these strikes are commonly near the striking platform and could be explained by the hammerstone bouncing off the cobble and

accidentally striking the surface twice. Figure 4.4 illustrates multiple crushed areas near the tool's edge /platform from the hammerstone bouncing or missing the target area for flake removal. The left image is of an experimental quartzite core. On the right is of the distal-ventral edge of an Eldon uniface from HhOv-484 (6.5x magnification) with similar features). This bounce is likely a product of the force of the hammerstone hitting the core as it vibrates on the stone upon impact. Another possibility is that these strikes, which appear as small and rounded crushed areas, may be from the flintknapper testing the material prior to flaking. Testing of raw stone is important for it can indicate if the stone is heterogeneous or not (Deforest 2006; Rast 2008). Each type of stone makes a different sound when struck by another stone (Deforest 2006). If the stone has a high pitched ring,



Figure 4.4 Multiple crushed areas near the tool's edge /platform (6.5x on right).

then that stone will likely fracture more consistently because of fewer internal flaws. Sound waves move slower and have a lower pitch when moving through a stone with more internal flaws. In addition, multiple scars can be produced by experienced flintknappers when working with a difficult material, which quartzite assuredly is.

Another free-hand technique is to throw one stone against another, or what Roe (2009:132) called “‘monkey/throwing’ percussion; unlike Roe, this technique is considered here as part of the free-hand technique. This technique was similarly recorded for traditional groups in Irian Jaya, where a hammerstone was sometimes thrown at a core to break it (Stout 2002:697). This method is straightforward and involves the simple action of throwing a cobble at a larger, preferably denser stone such as a boulder. This

technique has been argued for the creation of preforms for various stone tools on the Northern Plains, such as the Embarras Bipoints. In addition, particularly hard stones that are difficult to work may have been flaked through this means; however, this is less controlled than the other methods described here.

Heating /FBR Technique /Fire Spalling

The heating /FBR technique is based on two ideas: (1) that heating siliceous stone alters its composition and improves its knappability and (2) that heating stone prompts it to split, producing ideal platforms for flake removal. However, this may not be true for all types of stone, including varieties of quartzites (Whittaker 1994:72-74; Johnson 1998; Gryba and Kumai 2005; Roe 2009). Quartzites heated to or above 300 degrees Celsius have little to no significant property changes or improved flaking properties (Johnson 1998:9); in fact the melting point of quartz is over 1700° C (Johnson 1998:15). Heated quartzite does however gain a *sugary* appearance (Personal communication Jack Brink; Dan Meyer; Jason Roe 2009). It is unclear why quartzite gains a sugary appearance, but this does make it more difficult to flake. Some quartzite tools in northern Alberta were heated (Ives 1977:39), but this may have been a product of wild fires.

The second idea is that heat can break natural cobbles apart, producing a right-angled platform for flake removal that otherwise would not be naturally available on a round cobble. Dawe (1984 in Roe 2009:111-112) called this *fire spalling* and described this method as heating a stone for only 15-20 minutes as any longer would give it a sugary quality. This spalling occurs because trapped water molecules in the stone are converted to steam from the increased heat (*sensu* Jensen 1988). The trapped gas escapes from the stone through miniscule natural cracks. The movement of the gas expands the cracks resulting in the stone fracturing. Submerging heated stones in cold water can also spall a cobble as the shock of the change in temperature cracks the stone (Roe 2009:111). Basalt cores from Irian Jaya were treated in this manner where heat was used to break open larger boulders that would have been more difficult to otherwise knap (Stout 2002:697).

Quartzite was the preferred material for FBR and even specific types of quartzite were sought for their qualities in radiating heat (Oetelaar 2004:142). Reddening of the stone's surface is a common indicator of heating quartzite (Johnson 1998:30) and is noted

for a number of the Eldon uniface – Table 4.2 and Figure 4.5. Note the reddening is restricted to the dorsal upper left corner on the left image of Figure 4.5. As well, there is little to indicate a *sugary* appearance in Figure 4.5. FBR is also characterized by its sharp and right-angled breaks. FBR may have been used to make stone tools such as Eldon uniface only to the degree that it offered a way to flake a quartzite cobble and that it was a frugal use of a raw material as it would have had two functions: providing heat and also tool production.

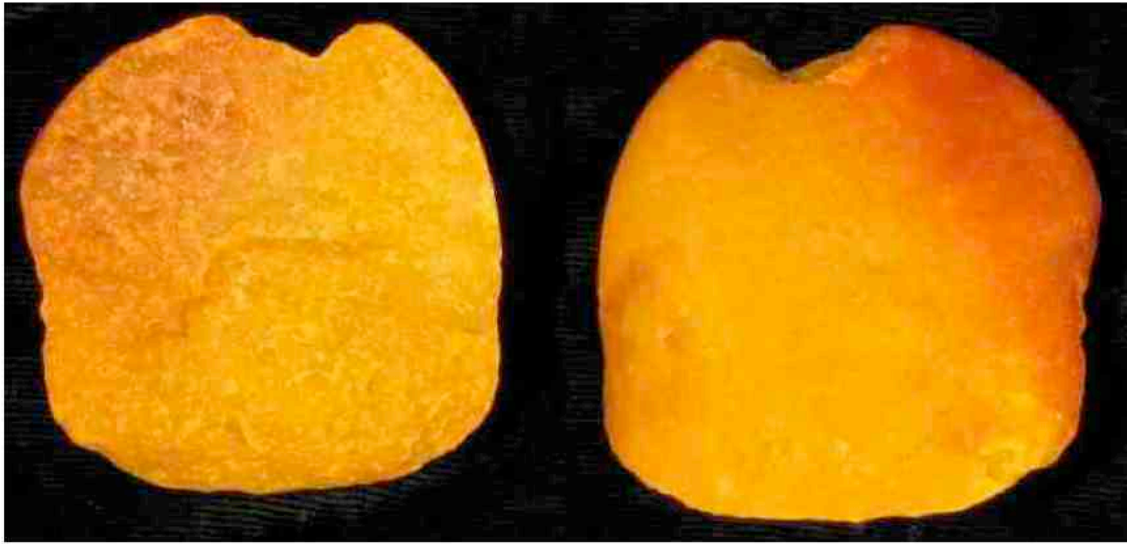


Figure 4.5 Reddened Eldon uniface from the UofS teaching collection.

Bipolar Technique

A bipolar technique is a third option to flaking a cobble. This is the method likely used to construct Eldon uniface. A great deal of force is needed to flake a raw quartzite cobble, which is possible with the bipolar but not the free-hand method, but this does not preclude the usage of heat.

The bipolar technique is simple and conservative of lithic material (Andrefsky 1994; Whittaker 1994; Morin 2004). Bipolar reduction economically reduces lithic material through increasing *energetic efficiency*, which makes this technique a frugal method of modifying low-quantity lithic resources (Berman et al. 1999:423). A hammerstone and an anvil are the two basic tools needed to bipolarly flake a cobble (Johnson 1996). A cobble is placed on top the anvil and struck with a hammerstone. Johnson (1996:54) varied the technique by using a small pebble as a punch when splitting

pebbles. Cobbles with “well-rounded ellipsoidal shape[s]” are ideal for bipolar percussion, which is a shape Rocky Mountain quartzite cobble have (Johnson 1991:79). As the hammer strikes the core, the force pushes the core into the anvil. This strike produces two shock waves (Andrefsky 1994; 1998:27; Mandal et al. 2000:120), which is really a transference of energy (in this order) between the flintknapper’s arm, the hammerstone, the cobble, the anvil, and back to the cobble. The first wave is from the hammerstone and it moves downward through the stone. The second wave is more like an echo, where the first wave is transferred to the anvil. This is only a partial transfer since some of the force moves upward through the stone, again, and another portion enters the anvil (the second wave). Inside the core, a “sudden and dramatic” fracture appears where the two forces meet (Mandal et al. 2000:120).

Bipolar percussion can create two striking platforms: one where the core rested on the anvil and the other where the core was struck by the hammer (Berman et al. 1990). This observation originated with François Bordes, who characterized bipolarly detached flakes as having two opposing bulbs of percussion (Bordes 1968:242 in Johnson 1996). Root’s (2004:74) definition did not refer to Bordes’ ‘two opposing bulbs’, but instead included

“the following attributes: (1) shattered or pointed platforms with little or no surface area; (2) wedging flake initiations; (3) evidence that force has been applied to both ends of the flake, such as crushing on opposite ends; (4) no bulbs of force (due to wedging initiations); (5) pronounced compression rings (due to compression-controlled flake propagation); and (6) a generally parallel-sided plan form. Flakes classified as bipolar must exhibit most but not all of these attributes. Bipolar flakes do not exhibit positive bulbs of force on opposite ends of the same flake interior surface. It is often difficult to distinguish bipolar flakes from bipolar cores”.

Roots’ definition works well for the purposes here, but is weak on explaining what ‘wedge flake initiations’ were. Johnson (1991) explained that these small, orange-slice shaped pieces break from the core’s striking platform upon the impact of the hammer. Once broken, these orange-slices, or wedges, are driven into the stone to act as a wedge to separate the spall from the core. What is not considered, however, is that these pieces are likely the bulb of percussion, which is why two opposing bulbs are rarely found and believed by some not to occur (eg. Johnson 1991). Wedges were also produced when experimentally flaking cobbles during this project.

In splitting the cobble via bipolar means, the hammerstone would be a dense and (likely) fist sized-cobble used to strike the larger quartzite nodule. In this project's recreation of Eldon unifaces it was found that the larger the hammerstone, the easier it was to flake the nodule. In fact, the easiest way to bipolarly knap a cobble was to use both hands to swing a large quartzite hammerstone that was roughly the size of one's head.

There are similarities and important differences between free-hand and bipolarly struck flakes. Both methods produce striking platforms and bulbs of percussion on the flakes, but the angle of detachment of a bipolar flake is closer to 90° (Berman et al. 1999). While there are two striking platforms on a bipolar flake, there is usually only one bulb of percussion located at the proximal end of the flake. A second bulb is more rare and is present on the distal end of the flake where the nodule had rested on an anvil. Bipolar flakes also tend to have more crushing "on opposite poles"; however "such patterns further can be due to wedging or hafting" (Berman et al. 1999:423). Bipolar flaking additionally produces more shatter than is usual with a free-hand method (Hayden et al. 1996b:19). This additional shatter is due to the greater amount of force that is exerted, which is also needed as quartzite is naturally a hard material. Shattering can additionally remove striking platforms, complicating the identification of these flakes. Another problem with identification is that one pole is commonly modified for use. For Eldon unifaces, one striking platform is commonly present on the proximal edge and the opposite pole was extensively flaked. Angled Corner Eldon unifaces are an exception where both poles are often retained and it is the lateral margins that are modified for use. It is because of these identification problems that the bipolar method cannot be assuredly claimed for how the spalls for Eldon unifaces were produced. The method was likely used, but the FBR and fire spalling techniques are also contenders. The free hand technique is less likely due to how incredibly hard it was to execute for quartzite cobbles in the experiments in comparison with these other two methods.

Examples of the Bipolar Technique from other Geographical Regions

There is more than one way to bipolarly flake stone, but the principles outlined above remain true. Bipolar technology was employed on the Northern Plains to produce pebble tools during and following the early-Middle Period (Cyr 2006; Wright 2006; Roe 2009),

but how the technique was applied is unknown. As was briefly mentioned in the previous chapter, bipolar percussion was used to construct adzes in Manitoba, but the authors did not discuss the method by which this was employed (eg. Brownlee 1995; Malasiuk 2001). A knowledgeable and experienced flintknapper, Tom Stevenson (personal communication, 2010), had success in splitting quartzite cobbles using round and conical hafted stone hammers, which he had made previously. He noted how the hammers would ‘punch’ the cobbles, leaving concentric rings on the striking platform. The flaked spalls were likewise predictably removed while the cobble was held in the hand of the knapper. Yet, there is no known information from archaeological sites of split cobbles and such hafted hammerstones being found in association.

On the Northwest Coast, cobbles “were set in a simple vice (a split and bound branch) on an anvil stone and struck with a very large hammerstone –a technique that can be described as a type of high-impact bipolar reduction” to produce spall tools (Morin 2004:292). A number of strikes were required to finally remove a flake from the core, but when accomplished a sharp flake was produced that needed no further modification and the proximal (striking platform) region could be easily and safely held in the hand. The Tahltan, however, used exposed bedrock as anvils (Albright 1984:59). The cobbles were held in one hand and hit with a hammerstone. Bedrock exposures like this are not common the Canadian Plains.

Duna speaking groups of eastern Papua-New Guinea wrapped chert cores in bark prior to bipolar flaking (White and Thomas 1972:278). Wrapped cores prevented scattering of flakes and encouraged the production of longer and thinner flakes. Such thinner flakes “maximize area but minimize thickness” (Stout 2002:714). Such a strategy involved more force to strike the core and greater accuracy in striking near the edge. In contrast to the Northwest coast example, the Papua-New Guinea method does not demonstrate the need for multiple strikes and this may be due to the difference in lithic materials.

On the western half of Papua-New Guinea, Irian Jaya, traditional groups had a simpler method of bipolar flaking. Basalt cobbles were struck with a hammerstone (called a *ya-winwin* that weighed between .5 and 1kg) as the core rested upon a driftwood anvil (called a *ya-sigita*) (Stout 2002:697). Nothing was used to secure the core into place

like the Tahltan did. Aborigine groups from Queensland Australia also used a bipolar technique to split stone. A stone would rest atop an anvil and would be struck from above, again without a brace (Moore 2004:62). Tabular scrapers from the Near East and Egypt were likewise created in a similar manner without the aid of a brace, although here this method is referred to as a *block-on-block* technique (Rosen 1983:79).

Experimental Recreation /Flintknapping

Urve Linname donated Rocky Mountain quartzite cobbles for the experimental recreation of Eldon unifaces. The difficulty encountered with flaking a cobble quickly altered the emphasis of the experiment from how to recreate Eldon unifaces to an emphasis on understanding how a cobble could be flaked at all. The sheer hardness of the stone proved infuriating when compared to the ease of flaking materials like chert or obsidian. As the author is not an expert flintknapper, the activity of flaking a quartzite cobble proved to be a hearty task in itself. No matter how well the process went, the task of recreating these tools brought the research back to Tilley's writing (discussed earlier in section 4.2) of lived perceptions.

A free-hand method was initially tried but abruptly failed. This attempt resulted in numerous scuff marks and the occasional small (3cm) flake along with frustration and embarrassment. A heated technique was not employed as the product of heated quartzite was already known. Examples of FBR are commonly uncovered at archaeological sites and the author was well acquainted with them. Throwing of cobbles, like that noted previously, was attempted to little avail. Like the free-hand method, few flakes were removed. Eventually, when larger flakes were removed through this means, they were fairly thick and blocky. Substantial amounts of shatter also resulted from this and it is likely that the initial failed attempts to break the stone by throwing produced internal fractures. When the cobble was thrown after the initial attempts, the internal fractures were exploited and flakes were detached in unpredictable and undesirable ways. It should be recognized; however, that the author's flint knapping skills in no way compare to Jason Roe's, and so this might be a difference of expertise.

If bipolar percussion was utilized, how was it implemented? As noted above, there are a number of ways to bipolarly flake a cobble. When compartmentalized, there are three main components to bipolar percussion: (1) the cobble rests on an anvil, (2) the

cobble must be vertical and have a somewhat flat surface at the top, and (3) the cobble is struck with a stone hammer from above. Something must be used to brace a cobble so that it remains vertically upright while the hammerstone strikes it. The cobble must likewise remain stable while the hammerstone strikes. Holding the cobble with one hand results in bashed fingers and limits the force that can be used to swing the hammerstone downward as there is only one hand free to do so. Having someone else hold the cobble additionally may result in bashed fingers and shatter cutting their hands. These are some likely reasons why bark and branches were mentioned in two of the examples above.

Another method was used and proposed here that had no known archaeological analog, but is simple enough that it may have been used. This simple method was to use other stones to hold the core in place. Stones (or sand) are also easier to obtain than bark or branches on the Northern Plains and even the cobbles that would later become cores could be used as part of a brace. These stones formed a cairn-like feature around the core and held it in that ideal, upright position. Swung in an arc, a larger stone struck the core. The results of this experiment were favorable as the cobbles were easily split, however with some unexpected results. Figure 4.6 illustrates a core that was split via the cairn method. The core split longitudinally, but the right half broke into blocky chunks as the hammerstone's force was released through internal flaws. The platform at the top was additionally mostly removed due to the area disintegrating into small fragments as the hammerstone made contact. The cobble shown in Figure 4.7 was struck without a brace while it rested atop an anvil. There are scars on both the top and bottom of the stone from hitting anvil and hammerstone; note that the scar on the bottom (left) of the cobble appears like a flake scar produced from a hammerstone. The flake is refitted here, on the top and angles down to the right. This cobble did not break longitudinally but rather at an angle due to internal flaws and a possible miss-step in the striking of the hammer.

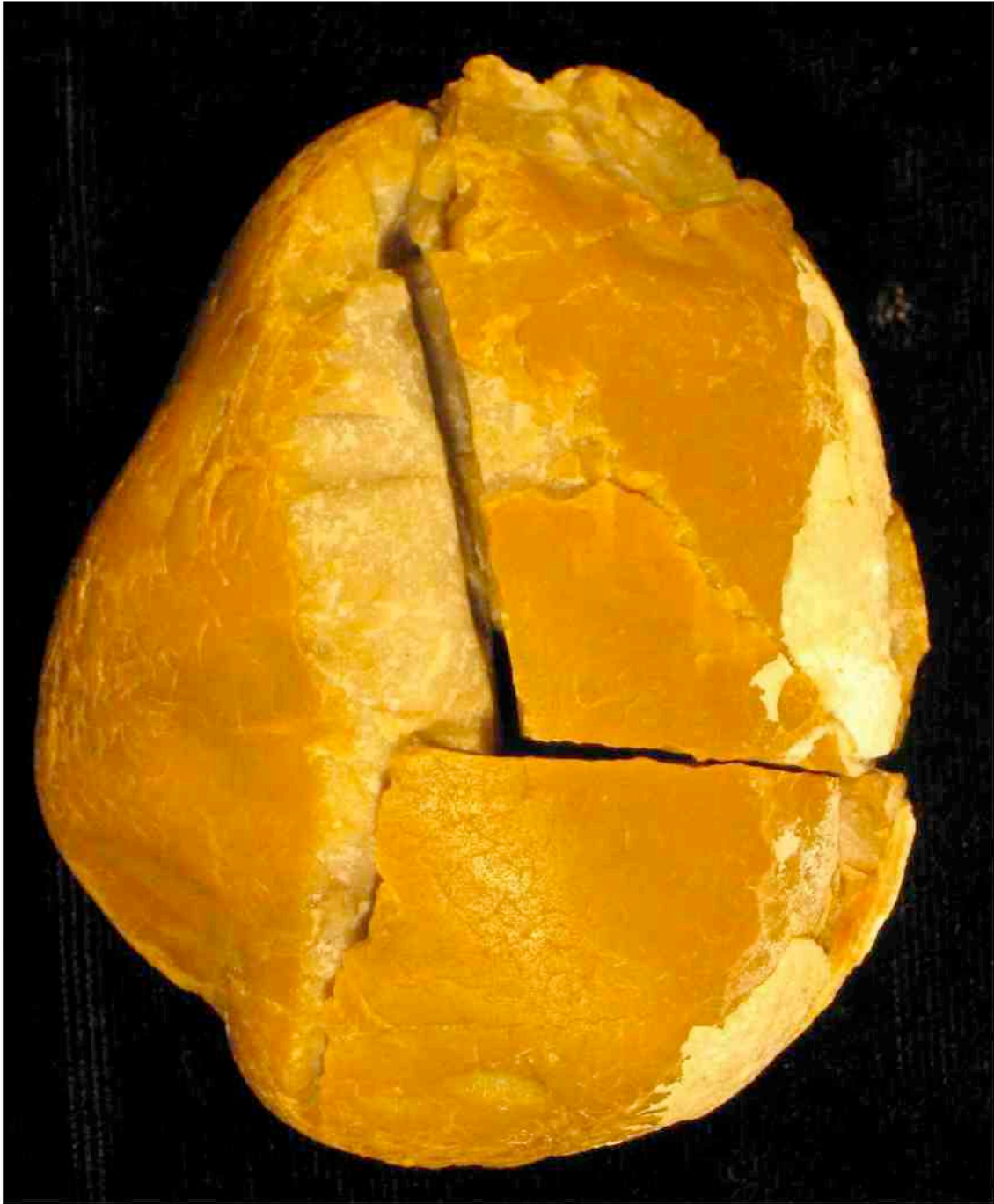


Figure 4.6 Split cobble from the cairn method.



Figure 4.7 Experimentally bipolarly struck core on anvil without brace.

It was noticed during the experimental bipolar knapping that flaws in the cobbles strongly influenced the results. The force that traveled through the stone exploited these flaws by moving outward through them, detaching blocky chunks. These chunks could be used to make a stone tool, but their morphology did not mimic that of an Eldon uniface. A further problem, or unexpected result, was that not all of the flakes had clear evidence of platforms (this was likewise noted in the bipolarly split pebbles provided by Karin Stueber from her studies in the Neutral Hills (Figure 2.3 in Chapter 2, section 2.1)). Many of the flakes lacked platforms and small scuffmarks roughly a centimeter away from the flake's edge were the only evidence of the blow. When the flakes were refitted to the core the platform became apparent as a negative space -where the platform was replaced by a gap between the flake and core; similar to Johnson's (1991) pebble splitting experiments. When the hammer struck the core the force and nature of the quartzite material shattered the platform area. The opposite end that rested on the anvil did retain evidence of a striking platform. This idea proposes that some of the platforms noted in the artifact assemblages may instead be at the end that rested on the anvil.

My bipolar percussion produced substantial amounts of shatter. This shatter, and the flakes themselves were sometimes ejected almost a meter away from the core when struck by the hammer. This supported what White and Thomas (1972) spoke of in reasoning why bark was used during bipolar knapping. Perhaps a similar approach occurred with making Eldon unifaces.

4.3.3 Edge Modification

Flake scar morphology is a product of how a hammer was used, what angle or location the hammer was held at, and what type of hammer was used (Plew and Woods 1985:223; Pelcin 1997; Root 2004:69). There are three tools discussed here that are used to modify stone tool edges, but only two of which were likely used on Eldon unifaces.

The first is a hard hammer. This tool was previously discussed in relation to bipolar percussion. Hard hammers produce larger flake scars because in comparison to the other two tools, more force is exerted and the hammer weighs more (Root 2004:69). These scars can be quite deep and steeply stepped in termination.

A soft hammer or billet is made from bone, antler or wood (Whittaker 1994; Andrefsky 1998:11). This is the second tool for modifying tool edges. This technique first emerged during the lower Acheulian period in Europe (Adams 1999:16); the hard hammer is much older. Characteristically, a billet produces thin and long flakes, and provides more control of the direction of flake removal than its sibling hard hammer. In cross section, billet scars tend to be shallower and flatter than hard hammer scars (Moore 2004:68). Most Eldon unifaces have flake scars that were made by soft hammers. These flake scars are found on areas where the edges were thinned, in particular along the lateral sides, rarely on the distal edges, and even more rarely on the proximal edge. Soft hammer flake scars run deep into the pieces with the aim of not only thinning the edges but also thinning the center of the tools. Thinning can likewise increase the chance of a sirt fracture, where the tool can split down the middle (Moore 2004:66). A balance needed to be struck between making the piece thin, but not too thin. Thinning of Eldon unifaces further indicates skill level, as less skilled knappers frequently focus less attention on removing the dorsal ridges of tools (Stout 2002:706). This is a result of differences in motor skill between skilled and unskilled flintknappers.

In contrast, the third and final tool, the pressure flaker, produces the thinnest and smallest flakes (Root 2004:69). The scars are often hinged or feather terminated. Pressure flaking involves applying pressure forcefully to an edge with a pointed tool of antler or bone (Andrefsky 1998:11). This allows for a very controlled removal of small, thin flakes to sharpen an edge. Pressure flaking also uses less force than billets or hammers. This reduction in force may not be suitable for quartzites as they are very hard and require substantial force to break. Eldon uniface edge modification was performed with a hard or soft hammer or billet, but not a pressure flaker as the majority of the scars are too large to have been made by a pressure flaker.

Details & Inferences on Edge Modification

Not all Eldon uniface edges were evenly modified. There were differences in the number of edges modified according to the proposed types. This variation in which edges were modified may be correlated to the preform's shape, where the freshly struck flake (preform) had a shape that was already ideal and hence did not need further edge modification. In other words, the shape of the original flake, or preform, has implications

for what occurred during the edge modification and perhaps for the resultant shape that the finished Eldon uniface took. This has also been noted for other tool forms in different regions of the world (Kuhn 1992a). A further limiting factor on tool formation is the size of the original cobble (Kuhn 1992a:117-119). Eldon unifaces were substantially smaller in the Gowen site assemblage than others. This was likely because the available raw material was substantially smaller as implied by a few Eldon unifaces that had cortex on the proximal ends on both dorsal and ventral surfaces, but were otherwise identical in morphology to other, more typical Eldon unifaces. This was a matter of surface area, where a restriction of space did not allow substantial edge modification.

Angled corner Eldon unifaces differ from other Eldon unifaces in shape. For the Corner Eldon unifaces, the distal and proximal edges were heavily modified with little to no edge modification to the lateral edges. The classic type had a tapered proximal half, and edge modification along both lateral edges and the distal or working edge. The lateral modification might be related to hafting as this promotes a more secure fitting with a binding wrapped around the tool and handle (Rots and Vermeersch 2000). Sometimes thinning flakes were removed from the proximal edge. Side Eldon unifaces, by the very nature of their name, received edge modification along only one lateral edge. The final type, amorphous Eldon unifaces, had edge modification on any or all edges.

A number of different techniques can be used to prepare a tool's edge for flake removal. Most of these are intended to reduce the chance of breaking the preform. One such technique was to pound the side of a preform to remove small projections or overhangs (Stout 2002:699). Another was to microflake the edge (Stout 2002:699). This removed small strips of material to create a more stable platform. A third technique was to rub the hammerstone upon the edges (Stout 2002:699). This reduced material along the edge and provided a more obtuse angle, strengthening and lessening the chance of shatter. This likewise produced a flat area that allowed the hammerstone to better *grip* the preform's edge and allowed for more control and consistency in the flake removal. Evidence for such grinding is visible on some edges along the proximal and lateral margins of the Eldon unifaces. Pounding the edge might be evidenced by small crushed circles along the distal edges, but this might similarly be a product of testing the material or result from various taphonomic processes. It is unclear if microflaking the edge

occurred as the remnants of this action would have been removed by subsequent edge modification.

The distal edges of classic Eldon unifaces were frequently constructed on the opposite pole to the bulb of percussion. Tula adzes often had odd shapes because they too retained their large bulbs of percussion and even the creation of the adze blanks was considered odd (Moore 2004). However, the oddity had a function in that the retention of the bulbs prevented the tools from snapping during use. Sometimes an unusual knapping technique or oddly shaped stone tool is used to prevent tool failure during use. Such reasons may not be apparent to an observer who has never used the tool. Odd shapes occur in some of the heterogeneity found in the Classic Eldon category and throughout the Amorphous category. Tula adzes explain how thinning Eldon unifaces was a balancing act of not making the tool susceptible to snapping while also still functional in a haft and maintaining a shape that was socially acceptable.

Removal of thinning flakes is commonly the final step in making stone tools, at which point there is an increased chance of breakage (Stout 2002:707). This does not seem to be the case for Eldon unifaces as smaller flake scars along the edge margins overlap these thinning flake scars (Figure 4.8). Smaller hammerstones and perhaps a billet were likely used for the final edge modification. This was the case with traditional Irian Jaya groups who used smaller hammerstones when their cores or stone tools became increasingly smaller (Stout 2002:698).

Eldon unifaces may have been thinned to aid hafting, but this was a balancing act since a tool must still be thick enough to avoid snapping while in use (Gallagher 1977:410). Judging by ethnoarchaeological observations from Ethiopia, this thinning of hafted tools was performed only if the preform was too thick (Gallagher 1977). This explains why not all Eldon unifaces have thinning flake scars as sometimes the initially struck cobble spall was already thin enough for hafting.

Errors in Eldon unifaces were a product of working quartzite. Driskal (1986:54) proposed that knapping errors were produced by “natural flaws, transverse and hinge fractures, knots, overshot flakes, edge collapse, edge crushing, failure to thin, failure to negotiate a tabular facet and unsuccessful shaping” on the stone tool artifacts. Therefore, these flaws or errors were due to either the skill (or lack thereof) of the knapper and /or

the nature of the raw material itself. Some of Driskal's noted signs were evident on Eldon unifaces: hinge fractures, knots (Figure 4.9), edge crushing, failure to thin, and remnant

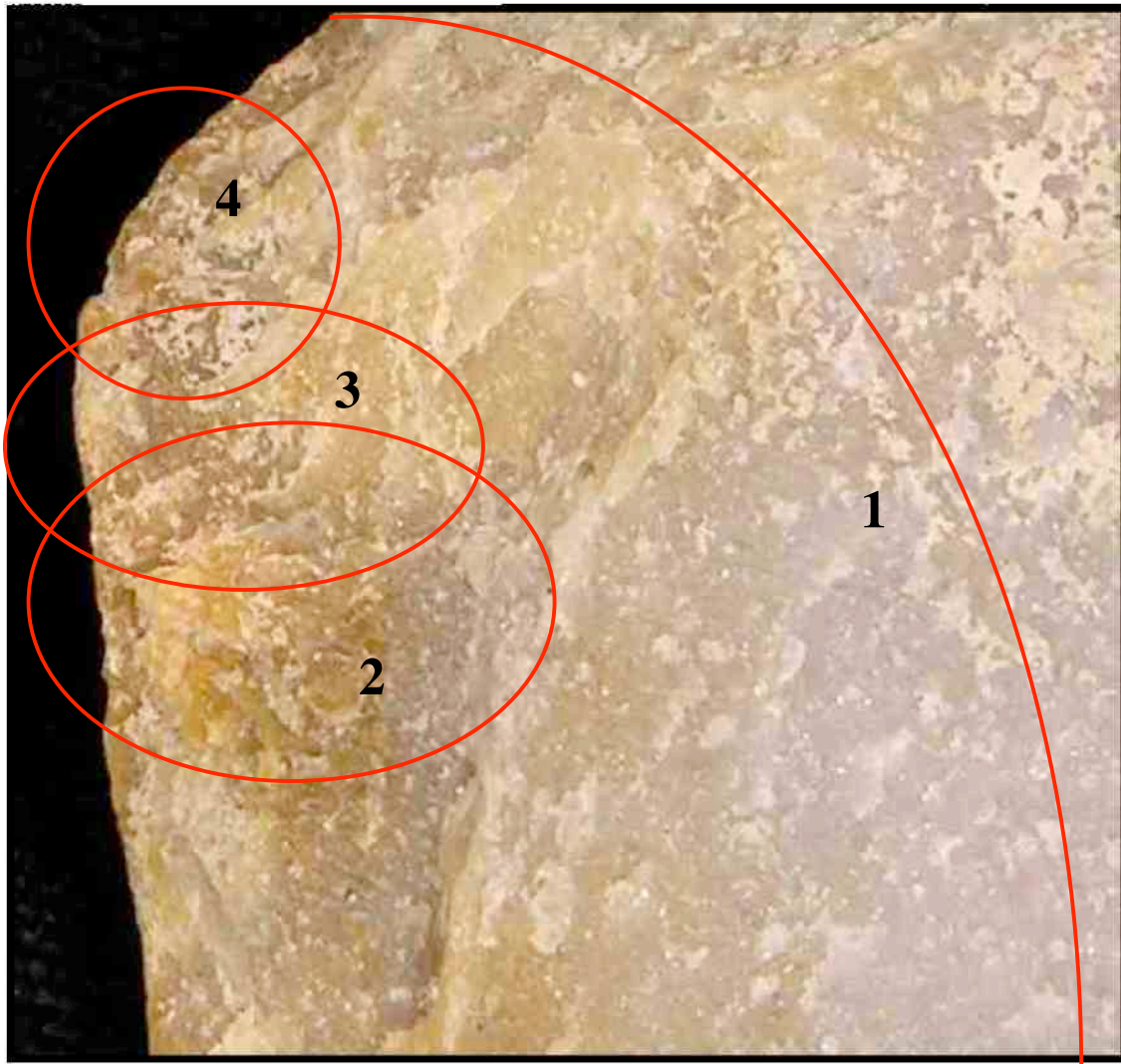


Figure 4.8 Overlapping flake scars on left distal corner of Eldon uniface from EgNp-63. Flake scars numbered according to the first to last removed.

tabular facets. The Eldon uniface flaws were likely due to the nature of the raw material and not due to the skill of the knapper. If anything, the fact that people made successful tools of this difficult raw stone material indicates they were especially talented at flintknapping.

4.3.4 Resharpener Strategies

Expedient tools were used for brief periods of time and generally used only once. Curated tools were the opposite of this. Eldon unifaces were curated. Curated tools required edge resharpener because they dulled over time. How often a tool had to be resharpener is a



Figure 4.9 Knot on distal area of a Classic Eldon uniface from EgNp-63, flanked by step terminated flaked scars (red lines inserted above or below the two scars).

reflection of the length of its use-life (Shott 2002:107). This section discusses how edge resharpener is identified on Eldon unifaces.

Although he did not define it, the term curation originated with Binford (Odell 2001). For this thesis, Shott's (1996) definition is used. He defined curation in terms of an artifact's usage in level of degrees, attempting to quantify curation within and between assemblages. This is in respect to the potential usage of a tool versus amount the tool was actually used. Curation was considered an indicator of a tool's importance since a curated tool was valuable and was not thrown away. Curated tools were maintained through edge resharpener, which occurred when the tool's edge was *perceived* to be dull and ineffective. Such curated tools were kept for longer periods of time and did not need to be

replaced as often as expedient tools. This makes curated tools scarce in the archaeological record (Hayden et al. 1996b). Eldon unifaces are uncommon in the Northern Plains assemblages because they are curated, lasted a long period of time and did not require constant replacement hence infrequently manufactured.

Edge resharpening alters an artifact's morphology. Because of resharpening, a tool's final shape is different than when it was originally formed "and is not the product of an initial premeditated plan of how a *finished* tool should look" (Hayden and Nelson 1981:888; Hayden 1984). A given kind of tool, therefore, can be a mixture of different shapes due to resharpening. Artifacts may also change function and therefore shape during their life-histories (Hayden 1984). This may have occurred with Eldon unifaces as it is a possibility that some of the tools might have been given a final bifacial edge to act as a celt. There are two celts in the EgNp-63 assemblage that are very similar in appearance to the Classic Eldon unifaces from that site, except for the fact that the distal edge has been bifacially flaked and one had small and shallow notches on both lateral margins; one of these celts is shown in Figure 4.10. The other celt has one bifacial edge with much of the cortex remaining on the ventral face. The celt that is shown has two bifacial edges and has similarly retained much of the cortex on the ventral face. Cortex was further retained on one face of the tools and the flaking patterns were similar to Classic Eldon unifaces in that there was an attempt to thin the tools. Yet, neither tool had retained their striking platforms or bulbs of percussion, which might be due to the fact that one had two bifacial edges and the other had a tapered proximal region perhaps prepared for hafting. Not every celt was formerly an Eldon uniface and cortex remaining on one face of the celts does not automatically imply a relationship with Eldon unifaces. Instead, there is likelihood that these tools are connected because they are in a cache (EgNp-63) that is otherwise composed of Eldon unifaces. As well, the flake scar patterns are similar to Eldon unifaces, and yes, a significant amount of cortex was left intact on one face.

A study of Ethiopian hide scrapers (*tutuma*) illustrated the morphological diversity produced through resharpening a tool's edges (Weedman 2002 and 2006). An average of 4 1/2 *tutuma* were used for working an individual hide, averaging 4 hours to complete (Weedman 2006:198). This implied that numerous resharpening episodes

occurred for each worked hide. Retouching was useful in tasks such as hide scraping as it made the edges not only sharper but also stronger (Lemorini et al. 2006:925). Continued

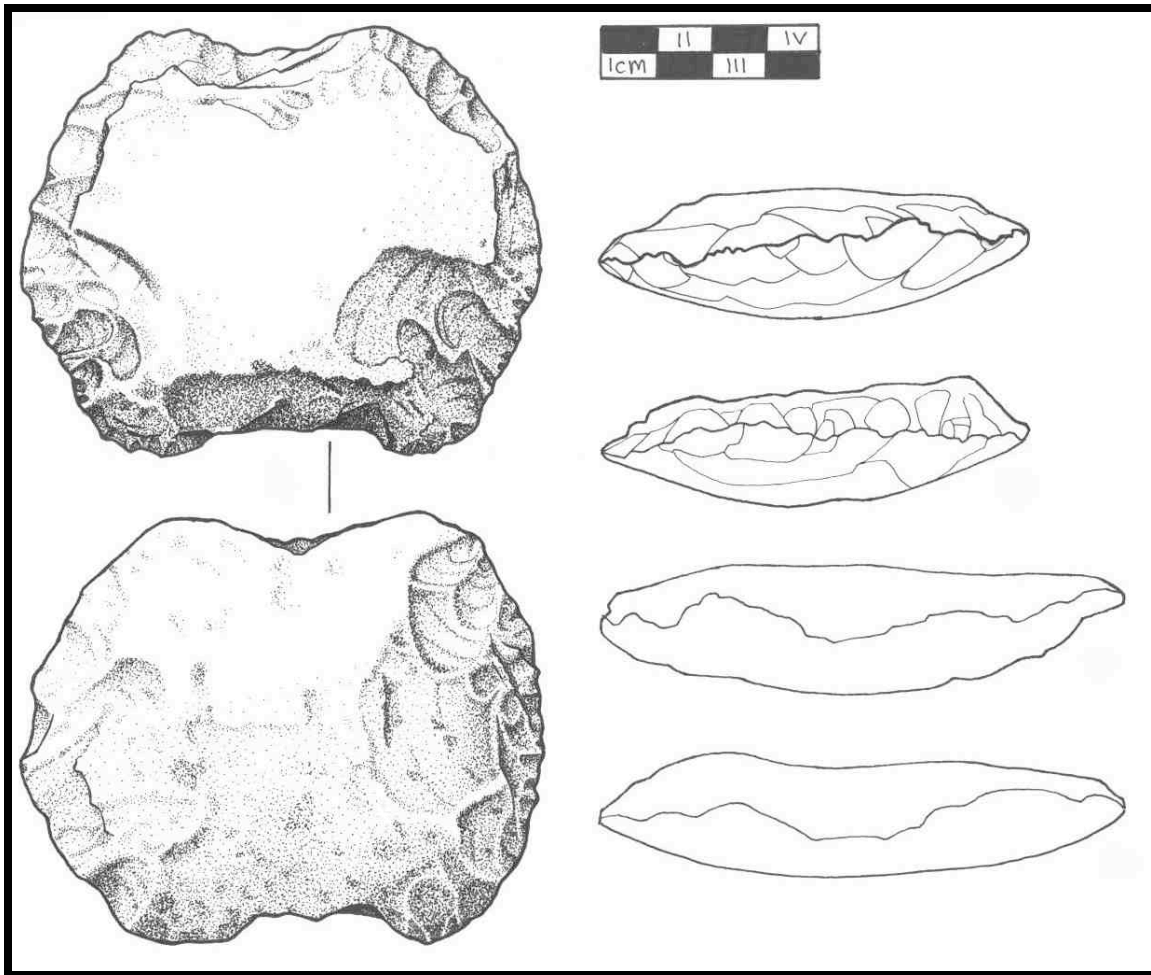


Figure 4.10 Celt from EgNp-63.

usefulness of *tutuma* was “assessed [through] the sharpness of an edge and the presence and depth of lateral and distal flake scars to determine the scraper’s stage of use” (Weedman 2006:205-6). In 49% of the cases, once the *tutuma* scraper’s edge became exhausted “the scraper [was] removed and one of the lateral edges or the proximal edge [was] refitted and used as the next scraping edge” (Weedman 2006:206). The edges were not modified for hafting to the degree that other scrapers were. Lack of edge modification for hafting allowed for additional edges to work material. The description and use of *tutuma* scrapers might apply to the amorphous style Eldon unifaces as these tools had multiple working edges.

Unused *tutuma* significantly differed from used *tutuma*. Differences were noted by Weedman (2006:198) in “comparing maximum lengths, distal thickness, breadth /length ratio, and thickness /length ratio, and edge angle”. There was further a difference in the number of edge spurs, which were made during resharpening. Spurs were defined as “either sharp projections represented by a 90 to 35 degree angle between the distal and lateral edge or projections located on the central working edge of the scraper that are at least 1 mm in height” (Weedman 2002:735). Older knappers left more spurs on the edges of their tools (Weedman 2002:732). Although such spurs were recognizable by ethnoarchaeologists, they were not recognized by all informants and instead were waved off as inconsequential. However, in one instance, one informant said spurs were inconsequential and shortly thereafter a spur ripped his hide (Weedman 2002:737). The tool was then replaced with a fresh un-spurred tool.

Quantifying Curation

In the past there have been four primary approaches in measuring tool reduction: “1) analysis of the relative abundance of different implement classes within an assemblage, 2) description of the nature of the retouching, 3) estimation of the original blank size, and 4) quantification of the extent of retouch scars” (Hiscock and Clarkson 2005:7). One method that is particularly attractive for its simplicity is Gordon’s (1993) method of counting the number of flake scar lines on a tool’s edge. This quantifies retouch on a scale of 0 to 4, counting the rows of flake scars observed along the edge. The reliability of the method is questioned however, for it does not consider the extent of retouch and changes in retouch direction /angle (Hiscock and Clarkson 2005:8). Shott (2002:107) moreover argued that a stone tool’s level of curation could be quantified and

“...estimated, if imperfectly, in several ways. In flake tools that retain the platform, for instance, platform dimensions give estimates of original flake size, although the predictive value of the relationship is weak. Usually, formal bifaces vary more in blade than in stem size, and blade size is inversely related to curation. Original blade size might be estimated from unused cache specimens. In these and surely in other ways, the amount of use experienced by tools might be estimated. Variation in curation among specimens in a category thereby approximates its failure or death distribution”

and in addition,

“The size of the scraper may have moreover influenced the length of a scraper’s use-life, with larger scrapers being more resistant to transverse fracture. Examples of detached distal portions of scrapers, with the working edge intact, suggest that this type of fracture did occur.” (Jefferies 1990:7)

Even so, tools such as Eldon unifaces may be suitable to Shott’s approach as these tools were not ‘separated’ for further use. A Weibull estimation is one such approach that can distinguish between accident, chance, and cumulative attritions for tools such as Eldon unifaces. Shott’s study specifically addressed projectile points. Tip angle and weight was used to argue that “heavier and more obtuse points generally survive longer because they resist chance fracture” (Shott 2002:93). For Eldon unifaces this would entail comparing the weights and edge angles in place of a projectile point’s tip angle. Figure 4.11 compares Classic Eldon unifaces in weight and edge angle. The distribution of attributes does not suggest separate clusters, but a continued stretch of weight with a fairly equal distribution of angles. As stated previously, cobble size has an effect on tool shape and hence weight. The range in sizes may therefore represent differences in cobbles rather than curation.

Another method of measuring curation was performed on European Mousterian stone tool assemblages (Kuhn 1990 and 1992a:119; Hiscock and Attenbrow 2005; Hiscock and Clark 2005). This method entailed calculating the

“extent of retouch by the relative ‘height’ (ventral-dorsal) of retouch scars...calculates a quantitative measure of edge attrition by dividing the height of retouch scars above the ventral face (t) by the maximum thickness of the flake (T)...measurements were taken at right angles to the ventral surface and at the same point on the retouched edge. Both t and T can be measured directly using calipers...” “The index calculated...ranges from 0 to 1. A value of 0 represents no retouch and a value of 1 indicates that retouch scars have intersected with, or crossed, the point of maximum thickness.” (Hiscock and Clark 2005:10-11).

A second method Kuhn (1990) proposed was to divide the length of edge retouch (starting from the distal edge inward to where the flake scar ends), the edge angle, and the artifact’s maximum thickness. The divided number provided an index value and the higher the value, the more reduction that had taken place since the tool’s original conception. Kuhn’s index is fairly simple to replicate and applicable to any edge shape; however, it is best suited for unifacial tools that had “retouched flakes on which blows

were applied to the ventral face and created scars on the dorsal face “ (Hiscock and Clark 2005:11). The benefit of this method is that it does not consider biases of the overall morphology, and so different types can be compared which is useful for comparing the four Eldon types presented here.

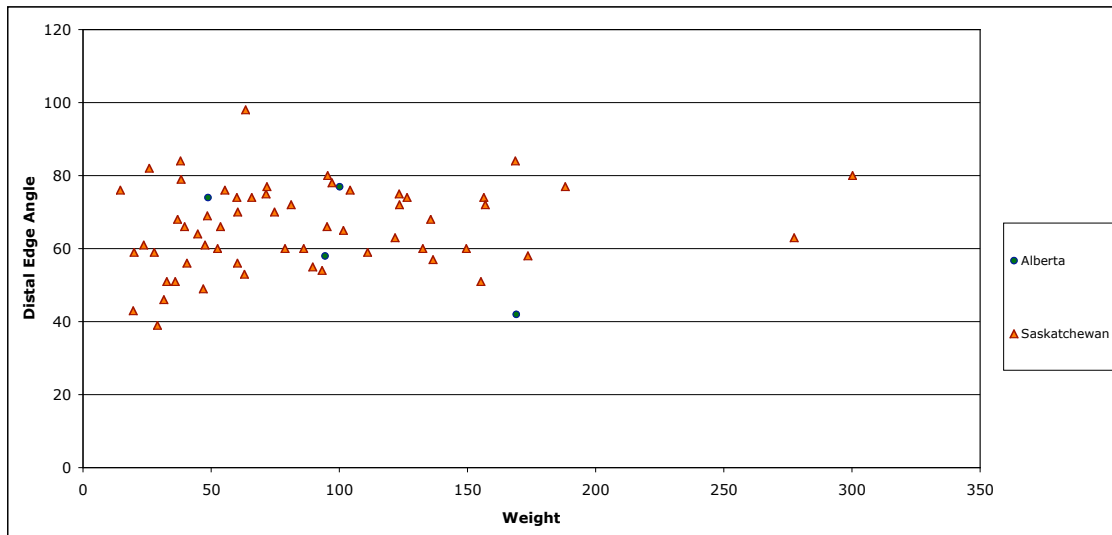


Figure 4.11 Comparison of weight and edge angles of Classic Eldon unifaces; only complete artifacts included.

Edge retouch on Eldon unifaces centered along the distal edge. There is little to indicate that resharpening occurred along the lateral margins. Because of this, it would be logical to assume that resharpening of only the distal edge would reduce a tool's length but not width, eventually creating a tool with equal dimensions. This would represent the end of its use-life, with little left to either hold or to have exposed outside the haft. Substantial numbers of artifacts with nearly equal widths and lengths shows that many of the tools were discarded because they were exhausted, as opposed to being cached for later use. Figure 4.12 compares length and width measurements for all Eldon uniface types. Figure 4.13 repeats Figure 4.12, but only for Classic Eldon unifaces as separated by site (Figures 4.12 and 4.13 compares dimensions from the Eldon unifaces that were analyzed in this project and not those encountered in the literature). This figure indicates that only some of the artifacts shared similarities in a width and length measurement. This indicates that a commonly perceived shape existed for Eldon unifaces and the

deviation of this shape (dulling) prompted resharpening. These similarities are not found in all the Eldon uniface types and indicate that not all the artifacts were exhausted.

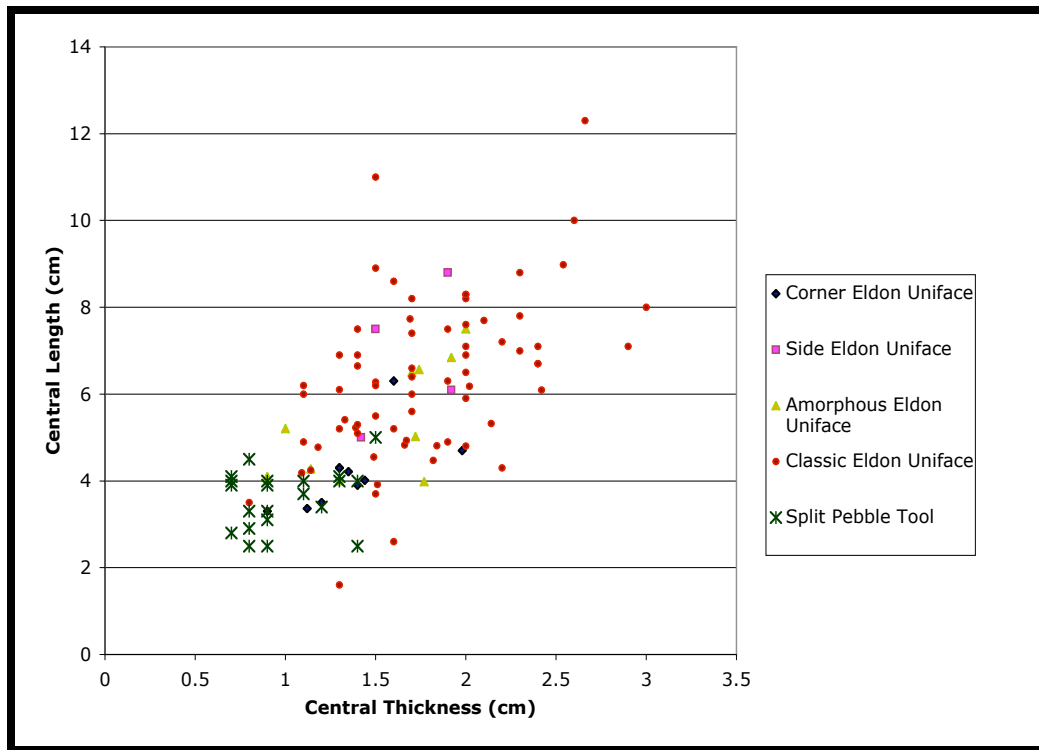


Figure 4.12 Width and length values (cm) for Eldon unifaces, as organized by type.

Resharpening gradually thins and shortens tools (Adams 1999:16). A comparison of thickness and length might suggest patterns in resharpening. Ideally, the longest and thickest of the Classic Eldon unifaces should be the least used of the assemblage, and the shortest and thinnest the most used. Figure 4.14 depicts the difference between the central length and thicknesses of Classic Eldon unifaces. Thickness was recorded for three different positions: proximal, medial, and distal. These three locations were matched with the central length of the tools. The comparison of these three matches produced overlap in the central region of the chart, but the proximal thickness and central length was consistently lower on the chart, distal thickness and central length was more consistently in the middle region, and the third match, medial thickness and central length was higher. This separation indicates that the distal region was consistently thinner than the medial region, indicating it received more edge modification or rejuvenation than the medial

region. There was little difference in the spread of length measurements according to these three thickness measurements, which signifies that thickness may not have had a

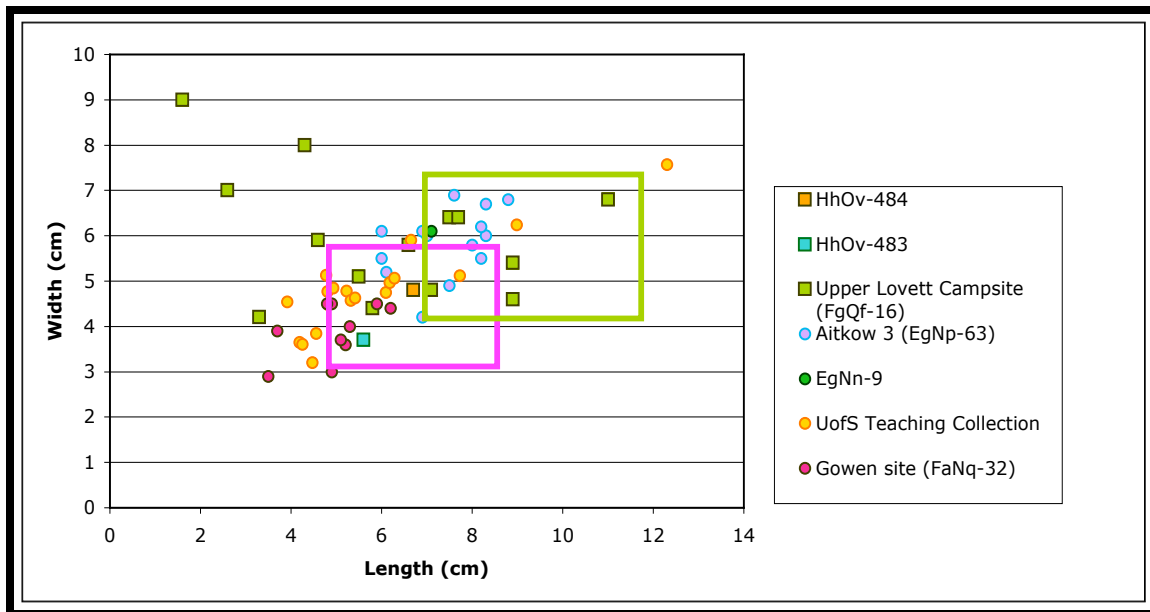


Figure 4.13 Comparison of length and widths of Classic Eldon unifaces as separated by site /collection. Within the pink box is a cluster of the UofS Teaching collection artifacts and within the green box is a cluster of the Aitkow 3 artifacts.

significant relationship to the length of the tool. As indicated by Figure 4.14, the difference in thickness is not correlated with significant differences in length.

Artifacts from FgQf-16 had a pattern to resharpening not found in the other collections but similar to artifacts from the Northwest Coast. For Pasika Complex choppers, Haley (1996:60) observed that “once the edge became too battered or thick to resharpen, it could be rejuvenated by the removal of a large flake that included the entire edge area”. The chopper’s distal edge was struck on the side or dead-center, removing the entire edge in the form of a burin-like spall (Figure 4.15). Once removed, the edge was reworked and used again. This strategy was additionally employed in Europe during the Mousterian, where a tool’s edge was rejuvenated through burination (Perles 1982). This appears true for the Hinton artifacts, where one resharpening strategy was to remove the edge with a blow to a lateral margin, acting almost like a burin-flake. The second was to hit the tool from the ventral surface, almost dead center. Breaks or snaps also occurred on

hafted tools that were used under large load pressures. Unintentional breaks and snaps often “leaves a smooth surface with or without a small lip on the dorsal or ventral edge of

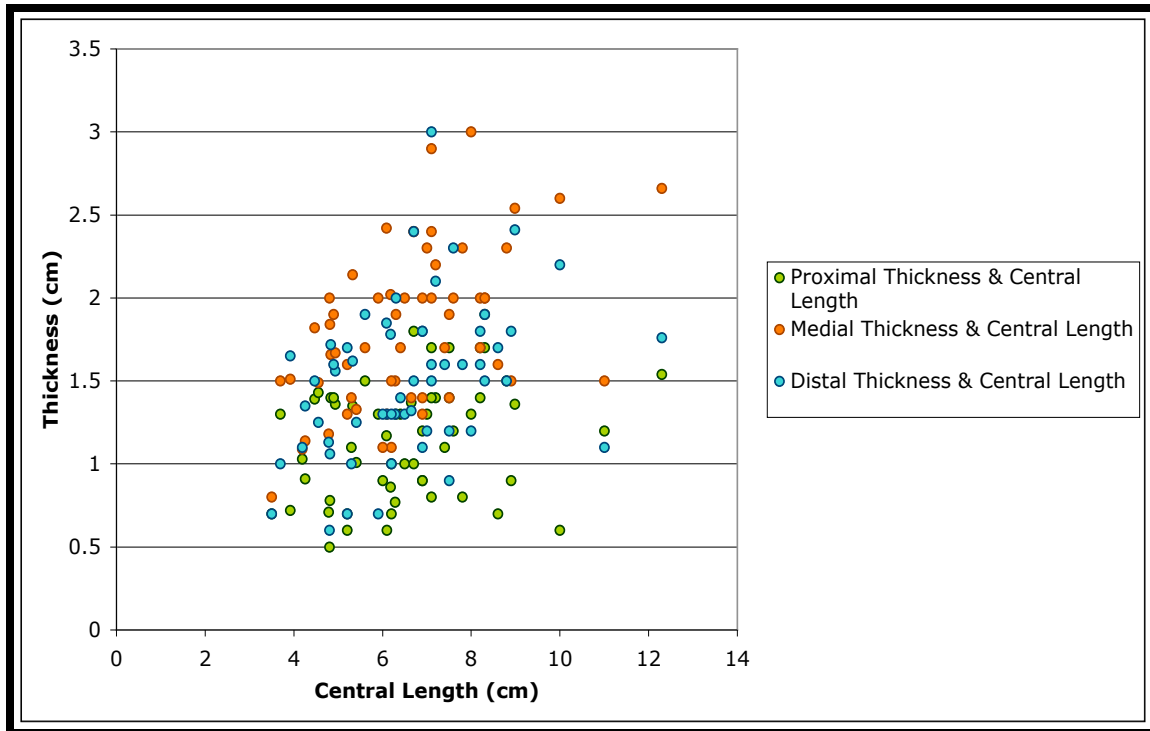


Figure 4.14 Comparison of thicknesses recorded from three areas on a Classic Eldon uniface and individually compared with the central (maximum) length.

the break surface, and that accidental breakage leaves either an irregular surface or a well-defined lip on the ventral or dorsal edge” (Owen 1982:77). Protruding lips are additionally common when a tool is intentionally broken by being placed atop a hard surface and then struck from above with a hammer (Owen 1982:77). As shown in Figure 4.16, there is a small striking platform, lip and lines of percussion on the dead center of the ventral face where a line of white quartz crosses the surface and edge. It is highly likely, then, that some of the FgQf-16 tools were intentionally snapped, perhaps as a way to rejuvenate the working edge. Yet, there is a second possibility to why these tools were intentionally broken. It may be a product of dehafting the tool. Traditional groups from Kenya would de-haft their tools by striking the stone bit, propelling it out from the haft but sometimes breaking it in the process (Weedman 2002:738). This is an enticing idea as none of the broken artifacts indicated reuse, except for one that had a small number of

retouch scars along one of the broken edges. However, broken tools are sometimes given different roles; for instance, broken stone tools in the Maya Highlands were used as decorative elements in occupation areas (Hayden and Nelson 1981:892).

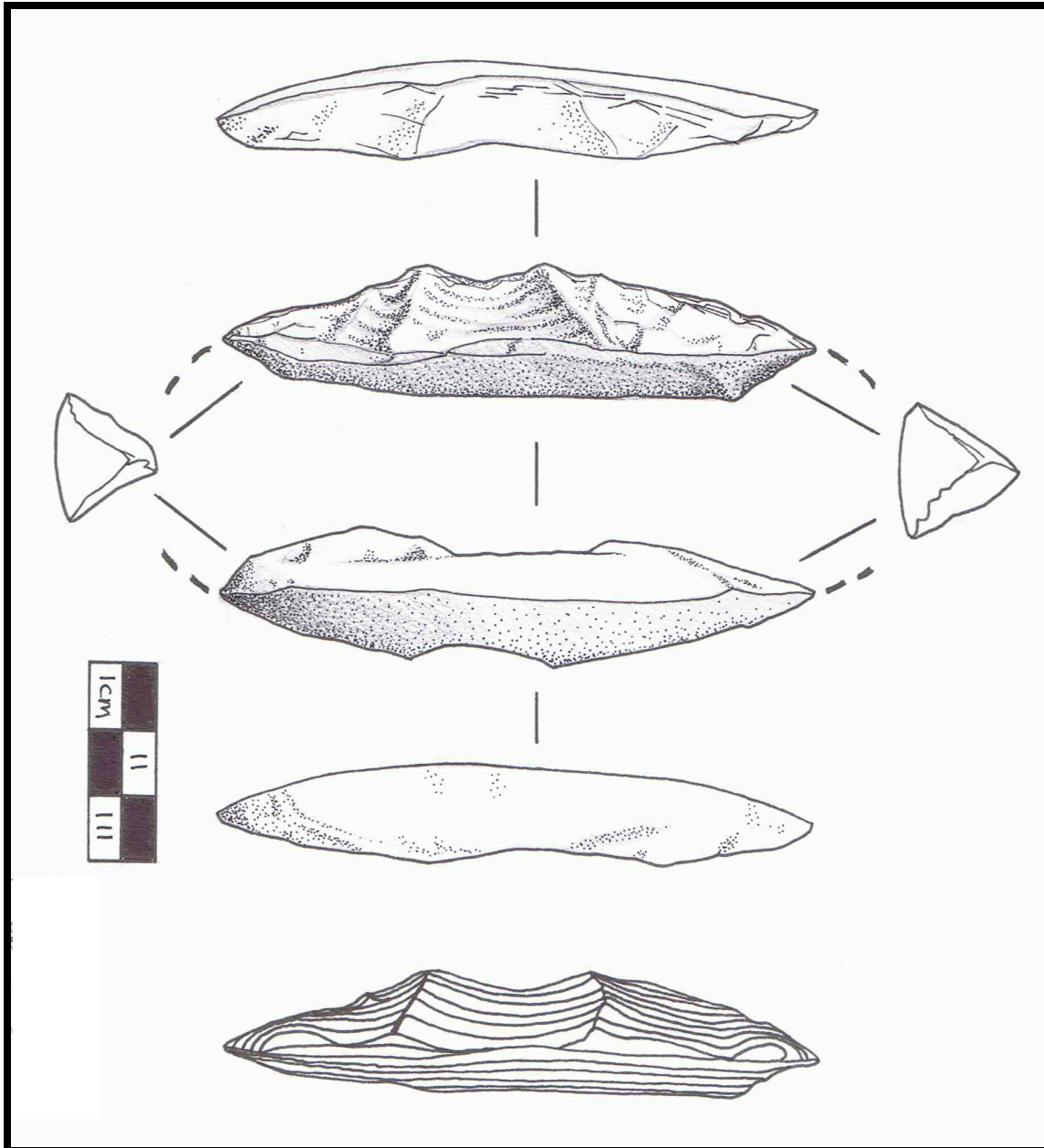


Figure 4.15 Possible removed working edge of Eldon uniface in a burin-like manner.



Figure 4.16 An example from FgQf-16 (no. 76) of a tool with the distal edge removed. In the center of the (left) image where the faded white line intersects the snapped region is a slight negative bulb /striking platform. This is likely where the blow to the tool occurred in removing the distal edge. The image on the right is a magnified image of where the edge was removed. On the lower right edge is a small and thin overhang. This overhang of stone would have been removed if the tool had been used, but it was not and suggests the tool was discarded following the removal of the distal edge.

Amorphous Eldon uniface edge reduction denotes they are exhausted tools. As the original working edge dulled another working edge was created, and so on and so forth. The previous edges were likely dulled on purpose to aid handling while the new edge was used; although, sometimes it is beneficial to have a tool with two coexisting operating edges, as suggested by Kuhn (1992a:122). Alternatively, the Amorphous tool's odd morphology may result from bipolar cobble flakes that did not have the shape desired by the flintknapper. However, this is not to say that quartzite cobbles were not an ideal material to construct Eldon unifaces from, as this material has advantages over other materials in being readily available on the Plains, tough enough to carry out many different tasks, and predictably flaked. The fact that some of the cobbles perhaps did not predictably flake and were transformed into an amorphous style would illustrate a level of *determination* in using lithic materials even when that material did not flake as expected.

During this thesis' experiments, the splitting of a nodule often resulted in two usable halves. Both halves of a split cobble could have been used to construct an Eldon uniface, although oddly no two Eldon unifaces from any of the particular sites were from the same parent nodule. Judging from the frugal nature discussed previously in manufacturing Eldon unifaces, as in how the tools were thinned and the proposed manufacture of amorphous style Eldon unifaces, why would the other forms of Eldon unifaces not be constructed from both halves of a split cobble? Other cultures such as those from Australia often used nodules to create multiple tools, such as cobbles that are used to make seven or more adze blades (Moore 2004). More sites identified in the future with Eldon unifaces might prove that both halves were used. Yet, if it is found that both halves were not used, then perhaps the other half was transformed into a different tool form or it was discarded because the other half often broke during the splitting of the nodule. The breakage of one half of a nodule did occur in one of the experiments, as shown previously.

For any tool there is a usable size. This is a physical constraint as opposed to a social constraint where the culture dictates the size or shape of an exhausted tool. This exhausted size is determined by when a tool can no longer be physically used and is not a factor of the tool's original size. Accordingly, because Tula adze blades are much smaller than an average Eldon uniface, the Tula adzes would become exhausted sooner because there is less surface area to re-sharpen.

The concept of identifying exhausted tools was discussed by Morrow (1996:583-584) with his analogy of a 'ham steak'. Employing a meat utility index, he criticized Kuhn's (1992a) usage of the reduction equation (utility /mass ratio) for contending that smaller tools were more efficient than larger tools. For a 'ham steak', Morrow wrote, a large or small 'ham steak' has bones that cannot be considered when equating how much edible food was available for the 'steak'. This is similar with stone tools, where the exhausted slug is a constant much like the ham bone that cannot be used and cannot be considered in how much a tool can be used. In response, Kuhn (1996) made a further analogy in that stone tools should instead be considered 'ham slices' and not ham off the bone. Kuhn pointed out that stone tools are resharpened by removing a narrow strip from the tool's working edge as opposed to a ham leg that requires cutting of flesh around a

bone (this is particularly relevant to the method employed at FgQf-16 as described earlier). More of a tool is available for use through the equal removal of material along the tool's edge, and hence the remaining slug is much smaller and is equal in shape for both small and large stone tools. While Kuhn is correct in noting Morrow's inappropriate analogy, Kuhn misses Morrow's central point: a portion of every tool is unusable for it is the section that is held either in the hand or haft. However, there still lies a logical problem in both Kuhn and Morrow's point, and that is in relation to levers; this argument needs no analogy. A large tool needs a large handle to be held in the hand or handle, while a smaller tool would require a smaller amount for the handle or handling. It is a balancing act that is especially important when considering large tools that are used for high energy work such as chopping or planing, and smaller tools such as projectile points that need to be secured in a haft. There needs to be a certain amount of weight that is placed in the handle or hand which is equal to or greater than that which is exposed and used for work. In fact, too much material exposed runs a higher chance of snapping, where the force load cannot be supported by the tool and a horizontal snap occurs that is very similar to those described for projectile points that fail under bending forces when striking a hard material (Odell and Cowan 1986). Kuhn (1996:593) came close to this reasoning when he wrote that "in most activities, most of the applied force comes (directly or indirectly) from the muscles and weight of the person using the tool, so that it is really a tool's gripping surface, and not its mass, that contributes most to its effectiveness". Kuhn is correct in underlining the importance of a tool's *gripping surface*, but underestimates the importance of the weight *IN the gripping surface*. Under this reasoning, a small tool is no more efficient than a larger tool for both are close to or have more than 50% of its bulk remaining at rest and unusable in the haft or hand, which suggests that neither the smaller or larger Eldon unifaces held an advantage over one with regard to the length of their use-lives.

4.4 Why cortex?

A commonality between spall tools in BC and Eldon unifaces is that the cortex was not removed from the ventral surface. Cortex for other unifacial stone tools on the Northern Plains is almost always on the dorsal as opposed to the ventral surface. This section

provides analogies for why cortex may have been retained. According to Design theory, the retention of cortex must be a benefit of some form and preferable to other option such as polishing a tool.

A rare example of cortex retention comes from the Great Plains Sioux, who used two stone tools to process hides: scrapers (*wahintke*) and unaltered stones (Belitz 1974). The *wahintke* was used to remove hair from the hide and as a squeegee to wick water and moisture from the hide. The unaltered stone tool was used to grind brain matter into the hides. The cortex was specifically left intact as this aided the process. Another example comes from the Nakota. Hides, in particular buffalo hides, were treated in a similar manner as the Sioux hides, but during the braining processes there is no mention of a tool being used to aid the process (Denig 2000:146-147). However, a stone scraper was used akin to a *wahintke*, but was replaced during the historic period with a metal blade. During the final step of processing a hide, the day after much of the work had occurred, “a fire [was] then made near and the skin slowly heated and rubbed with pumice stone or porous bone until it is about half dry, then taken out of the frame and drawn backward and forward round a strong cord of sinew which is tied at each end to the lodge pole” (Denig 2000:146-147). This pumice stone would be an unmodified stone similar to the Sioux’s. Using a stone in such a way should leave polish on the high, central portion of an Eldon uniface’s cortex face. This possibility is tested in the usewear chapter. If found true, Eldon unifaces may have had multiple functions: the cortex may have been used like an unaltered stone for braining a hide and the unifacial chipped edge used as a *wahintke* to de-hair the hide. By combining two functions, the amount of raw stone material needed for a task would have been reduced. This would be a niche. Additionally, the task itself would have become easier for there would be less switching of tools and less risk of loosing the stone tool (Rousseau 2004).

As explained above, the retention of cortex may have filled a niche. A niche could be a cultural perception in need or want or it may be functional in nature. A cultural niche might also be that cortex was retained for aesthetic values. Unfortunately, this cannot be tested archaeologically without drawing personal bias into the debate. Analogous tools from ethnohistorical or ethnographic contexts were researched during this thesis, but at no point was there a reference to cortex retention for aesthetic value. The functional value

of cortex is the only aspect that can be tested archaeologically for Eldon unifaces. This has involved experiments with tools with cortex on their working edges. It is proposed that polished stone surfaces are similar to the retention of cortex. It is likewise a hypothesis that cortex may have acted as a naturally polished surface and is why it was retained. Yet, what is the functional value of a polished stone surface?

Polishing or grinding can serve two purposes. The first is to dull an edge that could otherwise damage the haft (Stout 2002:700). The second is to provide a more stable working blade (Darwent 1998), which would be more likely for Eldon unifaces. An example of a stable working blade comes from the late European Mesolithic to early Neolithic period. Ground stone axes replaced chipped stone axes during this period because they did not break as easily while felling trees (Mathieu and Meyer 1997; Mandal et al. 2000). Wood is a very tough material and so the advantage of a stronger and less brittle tool to cut such a material is readily apparent.

Naturally polished stone (cortex) has the advantage over intentionally polished stone that it requires no time to construct. Another advantage is that 37% to 57% of a tool's original mass is lost when polished (Mandal et al. 2000:120). This again is a wasteful and time-consuming process that might be averted. The problem with this suggestion or linkage, nonetheless, is that Eldon unifaces only had one face or side that can be considered polished. The other face was flaked and hence was still brittle when working hard materials, if they were used for such tasks. However, experimental studies on spall tools from BC have indicated that the retention of the cortex actually strengthens the tool's cutting edge (Rousseau 2004). Further, working edges also tend to be sharper and finer when the cortex is left intact (Doll 1982:45). This, in combination with the fact that quartzite was naturally a very hard material in comparison to other available lithic materials on the Northern Plains, would suggest that cortex was recognized as a natural form of polish.

Conjecturally, time may have been saved through the construction of Eldon unifaces through two ways. First, a polished edge was produced through no cultural means, and second, only one side of the tool needed to be sharpened /flaked. Another advantage is that less material was lost through only flaking one side of a tool's edge.

Quartzite is a common material but it is readily available only during the warmer months (otherwise hidden by snow) and is a heavy material to transport.

4.5 Context of Manufacturing: Skill & Gender

Sex & Gender

It is difficult to prove if only men or women were involved in the creation of stone tools or if certain tools were used or made only by men or women. Burials are one of the few sources, where a man or woman was buried with tools or materials that were used for specific tasks. An example is the Island site in Delaware where women and children were buried with billets and pressure flakers, suggesting that flintknapping was not a gender specific activity (Custer et al. 1999 in Bamforth and Finlay 2008:21). Unfortunately, no known Eldon uniface has been recovered from a grave context in the Northern Plains.

Stone tool manufacturing is solely a man's task in contemporary societies in places such as Papua-New Guinea (White and Thomas 1972), Irian Jaya (Stout 2002), and Ethiopia (Gallagher 1977; Weedman 2006). Flintknapping knowledge was passed from father to son in Irian Jaya societies (Stout 2002), similar to the structure of Ethiopian hide workers (Weedman 2006:198). Somewhat similar are the Tahlitan, where stone tools were made by women and passed down from mother to daughter (Albright 1984:56). Women of the Duna society in Papua-New Guinea instead used organic based tools such as bamboo knives (White and Thomas 1972). Nonetheless, this separation of tool materials may be a product of personal bias and not a rigid division as suggested by these ethnoarchaeological examples. There is a problem with how archaeological arguments on gender are fundamentally structured, for "in western industrial societies, hard and utilitarian materials, technical gadgets, and a particular range of technical activities are stereotypically associated with men, whereas soft, supposedly non-technical activities are associated with women" (Dobres 1999:17). Archaeological ideas may be biased by previously held Western notions on the difference between men and women. This bias carries forward into the interpretation of archaeological assemblages. Eldon unifaces cannot therefore be easily circumscribed to the sole usage or manufacture by one gender or sex.

Traces of Skill

An artifact's morphology is a product of trial and error. Skill is the continual experimentation that is framed by experience; an experimentation that results in trials and errors. Experimentation influences design (Pye 1982:156-157). In a way, each experimentation and design represents a failure. As Pye wrote, "we design failures because we cannot make reliable predictions about responses" (1982:157). To this regard, every object is a prototype. In this fashion no artifact can be viewed as without flaw no matter the level of skill involved in said artifact. What this implies for archaeologists is that one should expect variations in artifact form and such variations may not attest to differences in skill but rather represent experimentations. It is unclear if this is present in the Eldon uniface assemblage, but should nonetheless be born in mind when considering levels of skill within this assemblage. This is a caveat.

For Irian Jaya adze blades, skill was not only reflected in the construction of the tools, but also the locating of suitable raw material (Stout 2002:694). This raw material consisted of basalt /andesite boulders that ranged in size from 30cm to several meters that were found on the banks of a nearby river. Boulders were obtained by a group of people led by an experienced knapper because finding the right type of material was difficult and required an expert's opinion. The locating of these materials took more than a day, so the group commonly had to spend the night along the riverbank. Some portions of this riverbank in addition had spiritual significance attached to them because of their possession of the lithic raw material (Stout 2002:697). Testing of boulders occurred in a group setting, where a test flake was removed and sometimes wetted down (called *magalingna*) so that the group could discuss the merits of that stone. Internal flaws were sometimes prized when they appeared as bands of color, so this process was more complex than simply looking for homogenous stones. The steps in tool production are distributed amongst the group, where a tool is worked into a particular form before being handed to another flintknapper for further working (Stout 2002:698). This produces a chain of activity where people are assigned manufacturing tasks based on their skill level.

Debitage can provide an objective measure of skill. For example, an unskilled flintknapper produces flakes with step-terminated flake scars, substantial amounts of shatter, and frequently discarded preforms with various imperfections (Shelley 1990).

The brittleness and hardness of a raw material and not the skill of the flintknapper can further account for the first two; these two are found on Eldon unifaces and are likely a product of the raw material and not the skill level of any tool maker. Another idea is that an unskilled craftsperson would create a product of lesser *quality* than a skilled craftsperson. Quality itself can be a difficult word to define since it is ripe with cultural connotations, but one way of looking at the term is by measuring the functionality of a material. A tool that fails would be considered of lesser quality than the tool that does not fail. For instance, the final modifications to a stone tool are commonly the most difficult to complete, and beginning flintknappers commonly fail at this step. In particular, bifaces can snap into two when the piece is thinned, producing what has been called *end-shock* (Gowlett et al. 2005). Except at EgNq-18, Eldon unifaces do not have evidence for breakage during manufacturing, but rather during use. This breakage is more commonly from resharpening and not a result of the tool failing.

Differences in artifact size may be another indicator of skill. In the case of Irian Jaya, small unusable adze blades were constructed by novices as these were intended to be learning /practicing pieces (Stout 2002:702). Further, the student flintknapper was not allowed to make pieces of comparable size to their masters as this would result in competition between the learner and teacher. However, there are two caveats to this approach for Eldon unifaces. One is that a difference in size could just as likely be a factor of individual taste, differences in function, or that there was no standardization in form. A difference in function can be recognized, but not the other two. Second, smaller scaled objects could be toy versions (eg. Pyszczyk 2003). This, nonetheless, is unlikely as the smallest tools come from the Gowen site and most of these artifacts have considerable wear.

Evidence for novice flintknapping can furthermore be found in the lack of dorsal ridge removal as many novice flint knappers tend to neglect the removal of material from the inner dorsal surface (Stout 2002:708). Quantitatively it was noted from Irian Jaya that only 2% of novice knappers removed the dorsal ridge, while 24% of expert knappers did. There is likewise a difference in patterning for attention given to each part of a tool, which is haphazard in novice knappers. Flakes alone likewise differ by levels of skill. Skilled knappers tend to produce flakes that “are larger, relatively thinner, and more

elongated and have steeper platform angles than those made by the unskilled group” (Stout 2002:710). Furthermore, “skilled knappers produce larger, flatter, and more elongated flakes with more oblique platform angles but without any significant difference in platform depth or thickness” (Stout 2002:711). Schick (in Stout 2002:713) contended that other common traits of unskilled knappers include insufficient thinning of a tool, making them too narrow and with irregular outline shapes. This is reminiscent of the two specimens from the Alberta boreal site, but the sample size is not large enough to say anything too securely. Notwithstanding, thinning any tool from any time period is likely a major hurdle for many beginners, as is also demonstrated in the author’s own flintknapper experiments. Although again, there is likely not enough of a sample truly demonstrate whether there is a difference in thickness sufficient to argue such an inference.

Differences between novice and experienced knappers may not be found at the same location. Bamforth and Finlay (2008:17) argued that the products of novice knappers were commonly left at the places where the raw materials were obtained. This is because “plentiful supplies would have provided ample opportunities for practice” and it was only the successfully manufactured objects that were carried back to the camp for use (Bamforth and Finlay 2008:17). This may be the case with the Eldon uniface samples as there is no known manufacturing debitage found in association with the artifacts at the sites.

The final aspect of skill is evidenced in split cobbles from British Columbia. Morin (2004:303) argued that there is little training involved in splitting cobbles for salmon tools, and instead the only prerequisite is having enough *strength* to perform the task. In contrast, I would argue that splitting cobbles is not a simple act, as illustrated with the number of different ways a cobble can be bipolarly flaked and in respect to how easy it is to modify the preform versus understanding how a cobble could be split. Brute strength is not required for splitting cobbles but instead a good understanding of where to best strike a cobble and how best to do so. Hypothetically, an experienced knapper could have been employed in the bipolar flaking of cobbles. The resulting flakes /preforms could then be modified by someone who is not a skilled knapper. This scenario implies a

level of craft organization that has not been shown for the early-Middle Period on the Plains.

4.6 Discussion /Conclusion

This chapter established how Eldon unifaces were constructed as guided by reference to Design theory and Sequence Models. Design theory looks to understand artifacts from the point of view of constraints involved in using and making them. Sequence Models look to the choices made in constructing artifacts and understanding why some choices were made while others were not. Such choices primarily center on why quartzite was chosen, why a bipolar percussion method was used to flake the cobbles, and why the cortex was left intact on one face of the artifacts. Some of these choices may have been influenced by how the stone itself reacted to flaking. This would be manifested in the retention of a knot on the dorsal surface. Further, the style and form given the Classic and Corner Eldon unifacs was perhaps related to addressing issues of being able to perform a specific job. It is unlikely that much of this related to non-functional issues as the modification was centered along the distal working edge and lateral margins that aided hafting. The tools were moreover thinned, which again relates to hafting. The retention of cortex may have been a non-functional attribute, but this is unlikely as there are a number of rationales provided for why cortex can benefit a tool's function. Therefore, style should be considered for Eldon unifaces in the realm of the choices that were made on how the tool was to function.

The gathering and choosing of quartzite cobbles for Eldon uniface manufacturing was also considered in this chapter. This stone material is abundant across Alberta and much of Saskatchewan, but in the Alberta boreal forest Beaver River Sandstone (BRS) was the more prevalent lithic material. While some cobbles may have been chosen over others for various physical features, color was likely not a factor. Additionally, obtaining the raw material may not have been controlled by certain people in a society as has been demonstrated in other societies in ethnoarchaeological studies. This stone material is furthermore a very hard metamorphic sandstone that provides a low wear rate for these very reasons. This attribute extends the use-life of the tools but can also make it difficult to flake.

For the most part, an idealized method was proposed in the manufacturing of Eldon unifaces for there are variables that can alter the method such as how a cobble initially fractures. Nonetheless, some of these variables are accounted for in the method submitted. This method is separated into four steps or components: (1) collect raw material, (2) bipolarly split raw material, (3) remove large flakes along the lateral margins, and to a lesser extent distal edge, to shape and thin the blank, and (4) remove finer flakes along lateral and distal margins to sharpen and shape the piece. Once a cobble had been collected (likely during the warmer months), the cobble was then split. This was feasibly accomplished through bipolar percussion, but a FBR or fire spalling technique may further have been employed. The ethnoarchaeological literature describes numerous ways to bipolarly split /flake a cobble, but which was used to split cobbles for making Eldon unifaces cannot be ascertained. Once the cobble was flaked, the edges of the blank were modified with soft and hard hammer billets. Not all the Eldon unifaces were modified the same way either. How thin the original flake was determined how much modification it was given. The size of the original cobble conjointly influenced the finished tool's size, shape, and thickness. Although the distal and lateral margins were modified, the proximal edge was frequently untouched, leaving the striking platform intact. Additionally, cortex was left on the ventral surface. This was likely done on purpose and may have filled a niche. Rationales for why the cortex was retained include: strengthens the working edge, acts as a naturally polished surface, used to brain /process hides similar to unaltered stones used by historic Nakota and Sioux groups.

Once a tool was manufactured it was likely hafted. The issues around and evidence for hafting are presented in the following chapter. These artifacts were then used and when they became dulled, resharpened. This is indicated by the clustering of length-width measurements and suggests that there were particular strategies involved. One such strategy is evidenced at FgQf-16 in Alberta, where the distal edge was completely removed so that a new edge could be created. This strategy is similar to that employed to rejuvenate some pebble tools in British Columbia, and is referenced by Kuhn (1992a) and Morrow (1996) in regards to 'ham steaks' and 'slices'.

The construction of Eldon unifaces may have required roughly five minutes of time as offered by similar studies (Gallagher 1977:410). This is in contrast to the

construction of tools made from bone or the act of grinding, pecking, or polishing stone tools (Kuhn 1992b:187). Ground adze blades from western Papua New Guinea could require an hour or more to make (Stout 2002:698), while British Mesolithic polished /ground stone axes required a number of hours to construct (Mandal et al. 2000). The difference in time is due to fewer steps involved in making an Eldon uniface and that the required steps are much less complex than those involved in ground, pecked, or polished stone tools. Further, Eldon unifaces do not have substantial thinning or shaping of the tool such as is performed on projectile points. This makes the construction process much simpler and faster. The resharpening strategy may likewise have been frugal. One approach is similar to Kuhn's (1992a) 'ham slices' where the distal edge was removed through a burinated blow or struck from dead-center. However, this might have been from de-hafting and was only evidenced at the FgQf-16 site.

Chapter 5

Function I: Morphology

5.0 Introduction

This chapter explores further aspects of Eldon uniface morphology and considers possible functions. The previous chapter defined these artifacts as made from quartzite cobbles that were bipolarly split and that a step process was used in shaping the blanks. Quartzite was used because it was easy to obtain and offered qualities not found in other lithic sources: it was hard and durable. These characteristics also matched cobble spall tools (CST) from British Columbia. Similarities in function between CSTs and Eldon unifaces could not be ascertained in the previous chapter, but in this and the next chapter such similarities are evaluated. This chapter's focus is to reason a function through morphology, principally looking at edge morphologies and the possibility of hafting. The next chapter (6) again addresses function but employs a usewear analysis approach.

5.1 Dimensions of Eldon Unifaces: Methodology

There are two approaches to defining artifacts: descriptive and metric. The latter is a “language [that] attempts to *quantify* the morphology by a set of discrete metric measures, characterizing an assemblage by the distribution of these measures such as the width-to-length ratio in the assemblage” (Grosman et al. 2008:3101). The former proposes a “descriptive language [that] attempts to capture the overall form of the object, by associating it with a familiar template” (Grosman et al. 2008:3101). Previous chapters have relied principally upon a qualitative approach. This chapter uses both quantitative and qualitative methods of analysis. The analysis of these attributes is what formed a list of the artifacts' modes that was used in Chapter 2 to argue for the four kinds of Eldon unifaces.

Weights and measures are the two basic components of a quantitative analysis. Weights were recorded to note variations among assemblages, as well as to consider the weight of portable toolkits, and how this might affect their function. Measurements were recorded according to their idealized placement on a typical Eldon uniface (Figure 5.1). These specific measurements were taken because of some initial questions that were

constructed at the outset of this project. For one, hafted tools tend to have differences in proximal and central region widths. Another is that the width of a distal edge may be correlated to a task and these widths are sometimes different from the central region widths. Lateral edges were similarly measured along with the length from the central proximal to distal edge as many of these tools tapered towards the proximal end and so had differences in length according to the lateral versus central line lengths. Because of such differences it was decided to measure the artifacts in three places to recognize these assumptions.

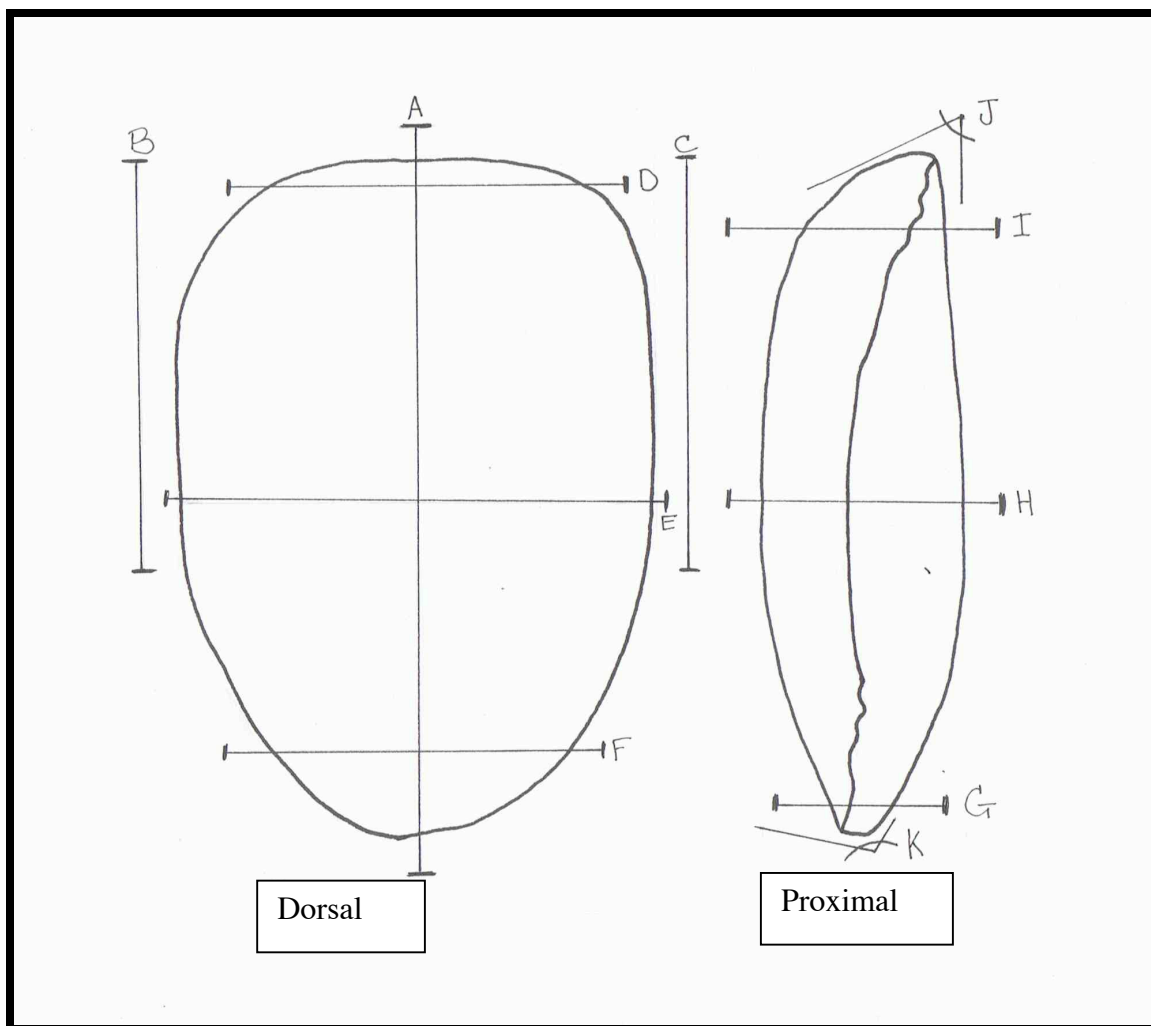


Figure 5.1 Placement of measurements on a generalized image of an Eldon uniface. The letters reference the measurements taken and recorded in an excel spreadsheet.

Metric attributes were recorded using a manual caliper. These measurements were tabulated to the nearest tenth of a centimeter. Weights were measured with an electronic scale and recorded to the nearest tenth of a gram. Edge angles were recorded with a protractor.

Patterns in the General Data

The following Figures are based on the quantitative data from Eldon uniface measurements. Numerous comparisons of the measured attributes were represented in scatter plots to test for patterns. These comparisons laid the groundwork for the morphological analysis that follows this section. Yet, not all of these tests produced positive results. One test that was positive is shown in Figure 5.2 that depicts the separation of split pebble tools from most of the Eldon unifaces and plus shows a general clustering of measurements within the four types. Further, Classic Eldon unifaces tend to range between 1.5 and 2.5cm in thickness and 4 and 8cm in length. This range might imply differences in resharpening strategies. Like in Figure 5.2, Figure 5.3, too, indicates

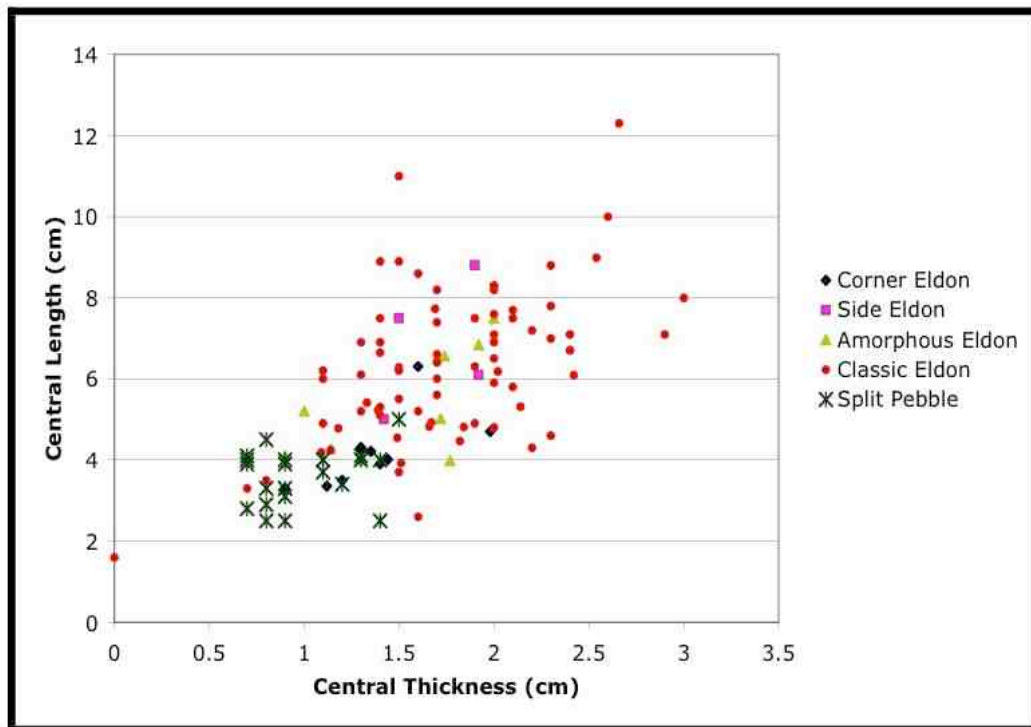


Figure 5.2 Comparison of central length and central thickness as organized by artifact type.

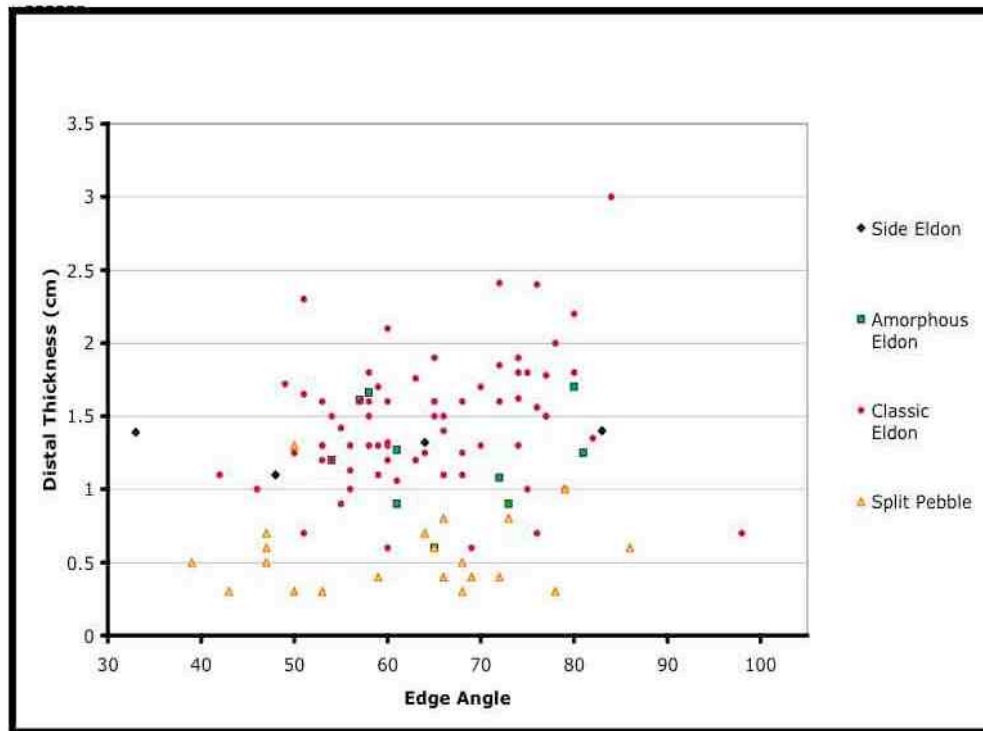


Figure 5.3 Comparison of distal widths and distal edge angles according to type.

the separation and difference between split pebbles and the Eldon types; Corner Eldon unifaces are not included in this graph because there are two opposing flaked edges and which one was used versus hafted could not be discerned without usewear studies, which were not performed on all of the artifacts nor at the time of collecting the metric attributes.

Differences in Eldon lengths might be indicative of skill (Shout 2002:705-706). Large specimens might represent prestigious items due to the skill required in their construction, similar to large stone tools in Irian Jaya that were constructed only by expert flintknappers. Less skilled flintknappers produce tools with greater variations in the widths and lengths, as opposed to the consistency of experienced knappers. Additionally, as discussed in the previous chapters, artifact length can be influenced by the size of the original cobble.

As shown in Figure 5.4, split pebbles are again noticeably different from the Eldon unifaces. The dominance in weight by Classic and Side Eldon unifaces brings to mind Morrow's (1996:587) comment that larger tools do not perform well in delicate

tasks and instead excel at “the application of force and leverage”. In addition, heavier tools tend to have longer lives (Shott 1996 and 2002:103), which would be the case with Eldon unifaces.

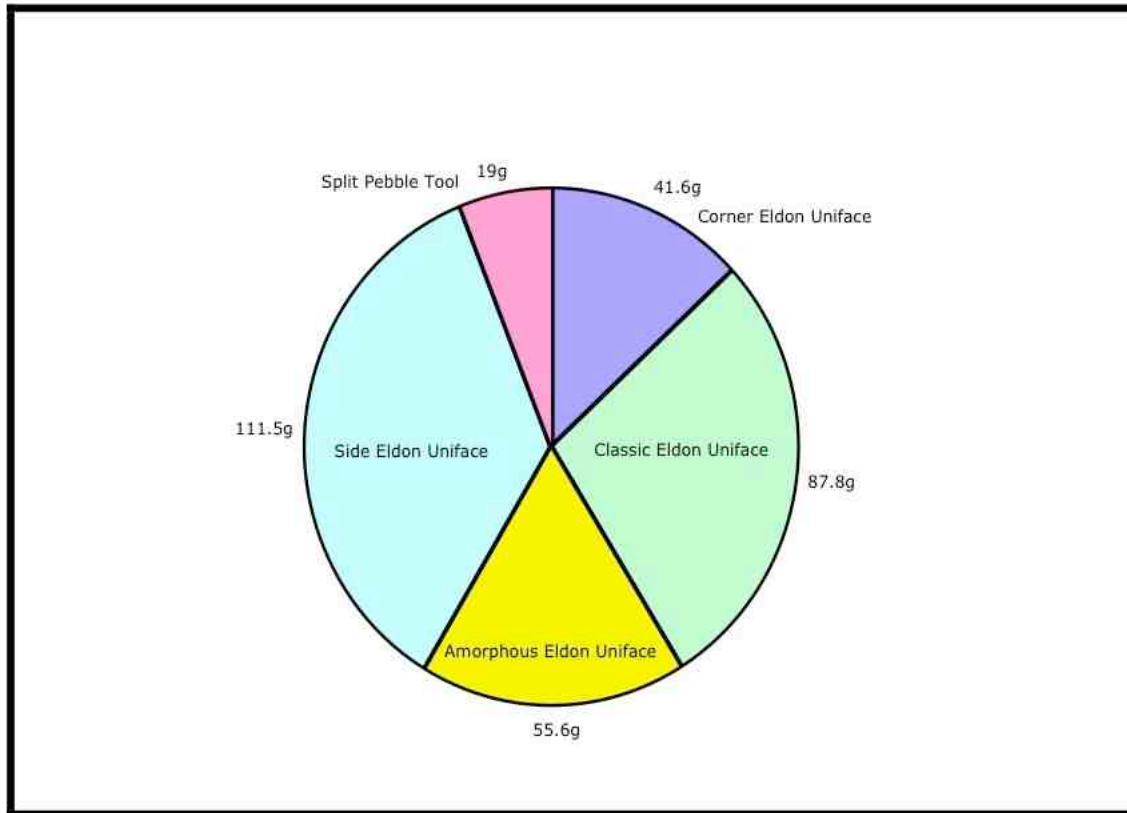


Figure 5.4 Comparison of average individual weight of an Eldon type.

Compilation of total metric attributes as recorded in averages and separated by artifact type is shown in Table 5.1. The distal, proximal, left, and right angle refer to edge angles that were recorded for all four sides of an artifact. They were only recorded when the edges were modified. *U*-mouths refer to the percentage of tools that had *U* shaped distal edges, which is discussed in the next section.

5.2 Function through Morphology

Not every edge is the same, morphologically. Archaeologically here have been many different ideas about what an edge can indicate. For one, an edge's shape can indicate how much it had been resharpened. The amount of resharpening can provide evidence of

an artifact's level of curation, among other factors. A second idea is that the shape of working edges might correlate to a function (eg. Hayden and Nelson 1981). Some authors

Table 5.1 Eldon uniface metric attribute averages.

Table 5.1					
Attribute	Type:				
	Corner	Classic	Amorphous	Side	Split Pebble
Weight	41.6	87.8	55.6	111.5	19
Middle Length	2.2	6.3	5.4	6.8	3.6
Left Length	3.5	2.3	2.1	5.5	2.9
Right Length	3.6	4	3.9	2.6	3
Distal Width	3.9	2.9	3.9	5	3.2
Central Width	2.2	2.9	2.5	6.2	3.5
Proximal Width	3.7	3.1	3.2	2.9	2.3
Proximal Thickness	1	1.1	1.2	1.1	0.6
Middle Thickness	1.4	1.7	1.5	1.7	1
Distal Thickness	1	1.4	1.2	1.3	0.5
Distal Angle	63.5	60.3	66.2	57	61.4
Proximal Angle	82.3	57.5	74	63	40
Left Angle	63	59.1	62.9	82.5	37.2
Right Angle	66	58.3	62	66.3	37.1
U Mouths: % of total	100	79	70	50	66.7

have used a one-to-one relationship between tool morphology and function in the aim of producing governing laws for other tools with similar morphologies (eg. Clark 1974).

Morphological studies of stone tools commonly focus on projectile points. Unifacial tools are usually lumped together, omitting differences. For projectile points, the proximal ends are the most important or diagnostic component in their morphological analysis as they can be distinctive of particular groups, regions, and /or time periods (Doll 1982). If this is true of points, why could it not also be true for unifaces? Increased research on uniface morphology (eg. Eldon unifaces) might show that they can additionally be used as diagnostics similar to points.

There can be multiple functions for a uniface, from planing wood to scraping hides. Some authors (eg. Andrefsky 1998) claim the form of a distal edge is dictated by the task it is employed in. However, form does not always correlate to a function (Odell 1985:22; Shea 1992:147), and as Hardy (et al. 2001:10976) wrote: “although traditional

typologies often have names that imply function (e.g., hand-axe and scraper), archaeologists have very little direct evidence of tool use”. For example, a hide processing function of a scraper is based on ethnographic analogies (Jensen 1988:66). With this association, tools of similar shapes in the archaeological record are given the same function although the relationship between tool form and function may not always bear true. This situation produces typologies that group artifacts together on similarities of form though they may not have similar functions.

This section examines Classic and Corner Eldon uniface working edge morphologies. In addition, how the tools were resharpened and how much resharpening occurred is considered. Lastly, edge angles are discussed as this affects how well a tool could function, and what type of function that was. The first section, edge morphology, indicates a function of working a medium to hard material for Eldon unifaces. However, there is considerable disagreement on what a tool’s morphology might mean for its function and it is recommended that such interpretations be made only in conjunction with other function -related analyses such as usewear.

5.2.1 Edge Shape

The function of a tool can strongly influence its shape, but such an influence may not extend to the tool’s entire morphology. There can also be more than one function in a tool, which brings two different sets of pressures to dictating a tool’s shape; for instance, hafting will influence the shape of a tool’s proximal region, and the tool’s job such as scraping, will influence the shape of the tool’s distal region. In regards to Eldon unifaces, does the shape of the distal edge correlate to a particular task? This task, one would infer, would have had an influencing pressure on the shape that this distal edge took.

Distal Edge Characterization

The outline shape of an Eldon uniface’s distal edge did not likely change much during its use-life. If the outlines were changed then there should be more variety of edge form in the assemblage. Conversely, the assemblage might reflect the possibility that the tools were discarded only when exhausted and hence only the tool’s final form is shown. This is unlikely considering the uniformity between and across assemblages.

The distal corners of Classic Eldon unifaces are commonly round and flair upwards. When viewed head-on this trait appears as *U*-shaped (Figure 5.5 and Table 5.2). The edges are also convex or straight, but not concave (Figure 5.6). In respect to Design theory, what type of constraint encouraged the development of such edge shapes? In particular, why were irregular, convex or straight edges adopted over concave edges and was the presence of a *U*-shaped mouth related to a function or cultural style, or perhaps is a trait that has no meaning at all? Wright (2006:441) defined tools with *U*-shaped distal edge cross-sections as adzes, which if taking the definition by Clark (1974:86) would indicate that these tools must have been (but not meaning exclusively) used to process wood.

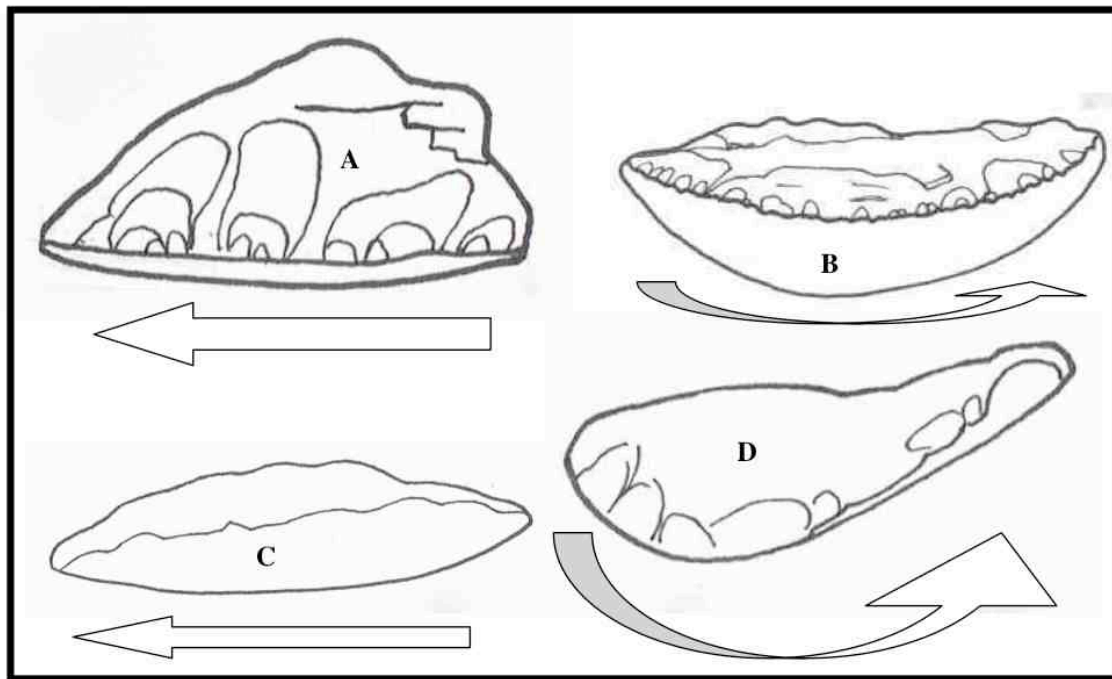


Figure 5.5 *U* shaped distal mouths on Classic Eldon unifaces.

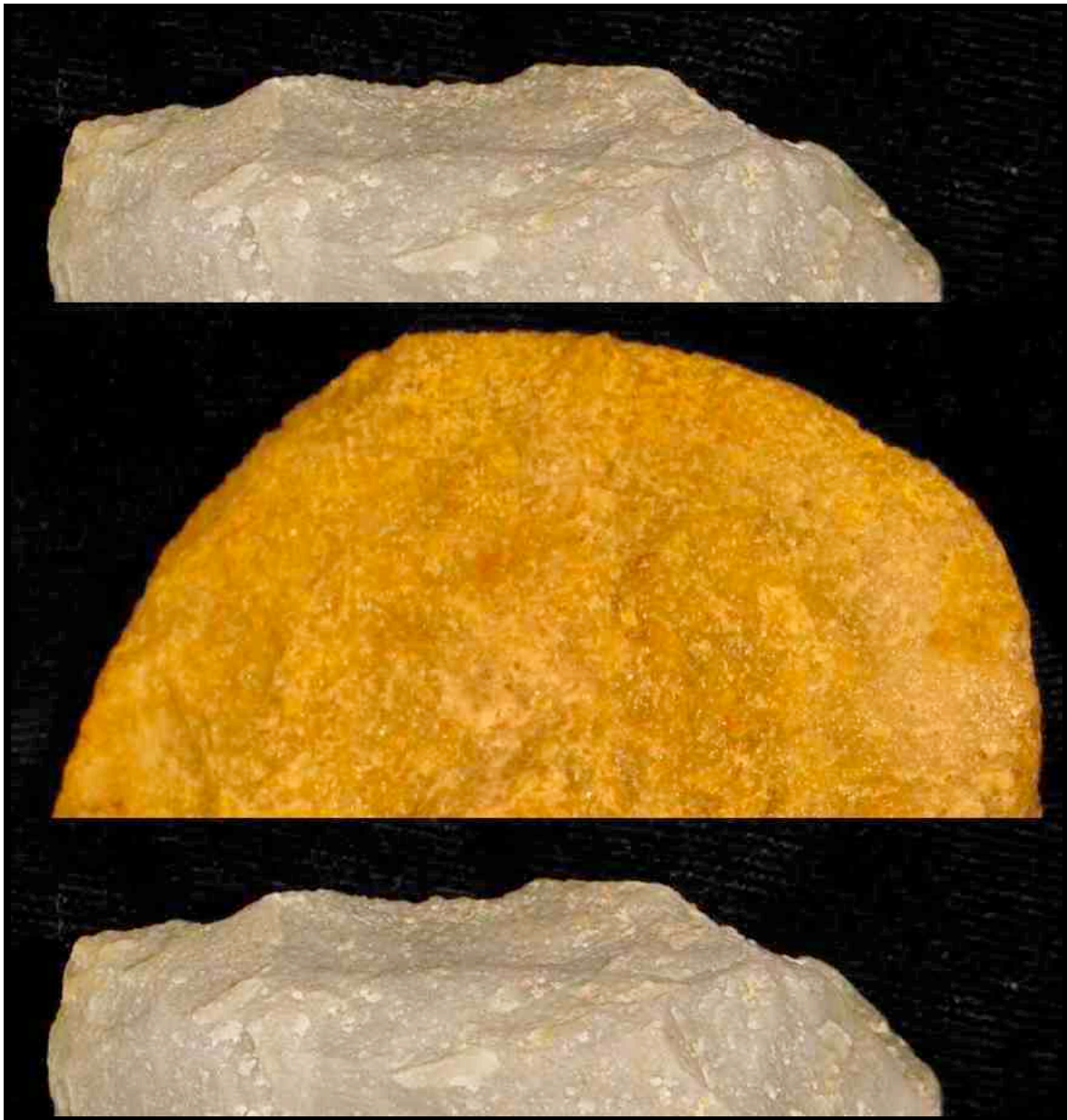


Figure 5.6 Distal edge shape outlines of Eldon unifaces. Top to bottom: EgNp-63 (No. 4), FaNq-32 (No. 120), and FgQf-16 (No. 64).

Table 5.2 Morphological traits of Eldon uniface.

Table 5.2

	Total	Overall Shape						Proximal Shape					Distal Shape				Umouth	Flat mouth
		Trapezoidal	Rectangular	Square	Ovoid	Triangular	Irregular	V - angled	Convex	Concave	Flat	Irregular	Flat	Angled	Convex	Irregular		
Classic Total	74	7	17	4	28	10	1	25	29	2	5	3	39	3	26	2	56	14
Classic Alberta	12	2	3	0	1	0	0	5	3	0	0	0	1	0	6	1	2	6
Classic Saskatchewan	62	5	14	4	27	10	1	20	26	2	5	3	38	3	20	1	54	8
Corner Total	9	1	5	3	0	0	0	0	2	0	7	0	5	1	3	0	9	0
Corner Alberta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corner Saskatchewan	9	1	5	3	0	0	0	0	2	0	7	0	5	1	3	0	9	0
Side Total	4	0	0	0	3	1	0	0	4	0	0	0	2	0	2	0	2	2
Side Alberta	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	1	0
Side Saskatchewan	3	0	0	0	2	1	0	0	3	0	0	0	2	0	1	0	1	2
Amorphous Total	9	0	1	3	3	0	2	3	3	0	0	3	2	0	5	2	6	3
Amorphous Alberta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amorphous Saskatchewan	9	0	1	3	3	0	2	3	3	0	0	3	2	0	5	2	6	3

Edge Thickness

Distal edge morphology may signify tool function (White 1968; Gallagher 1977; Andrefsky 1998; Moore 2004). Correlation between tool form and function has been suggested for artifacts like the Danish Neolithic endscrapers (Jensen 1988:70). These tools were separated according to edge thicknesses and the inferences supported through a usewear analysis. Based on this, flat and thin edged tools were used to work hides and thicker edged tools for woodworking. The differences of thickness were not specified and neither was the rationale for how thinness or thickness was defined. Returning to Table 5.2, there are differences between Eldon uniface types, but less so within types as indicated by the non-standardized distal thicknesses. According to the Danish scraper studies, Eldon unifaces would have been used to work wood, which also agrees with Walker's (1992:55-58) original suggestion for the Gowen site artifacts.

Edge Shape

There are discrepancies in what constitutes, morphologically, a woodworking tool. Moore (2004) argued that woodworking tools commonly had straight edge morphologies. When hafted, straight edged tools provided wider areas of contact than other edge outlines, but also ran the risk of “dig[ing] in and wrench[ing] the tool from the haft” (Moore 2004:70), especially when the corners were straight and angled unlike the *u*-shaped mouths. Clark (1974:88) instead characterized the tools by their “curvature or arc of the cutting edge” and Brownlee (1995) remarked on their flat ventral regions. Irian Jaya adze blades instead had beveled convex working edges (Stout 2002:700). In the eastern half of Papua New Guinea there were, in addition, a multitude of different tool forms used for woodworking (Clark 1965 In Mandel et al. 2000:118). These tools had specific names, such as *utuviya*, which were used to cut

“down the large trunks needed for making canoes. Lighter straight-edged adzes (*kasiwi*) were used for shaping or trimming boards or logs needed for building purposes. Stout but narrow blades (*kavilahi*) were chosen for hollowing out the insides of canoes, mounted either as axes or adzes to suit the requirements of the work. Narrow chisels (*ginesosu*) were used for cutting the grooves and holes required in building canoes or houses and lastly were the crude ‘*utuheme*’ used for clearing scrub for gardens ” (Mandel et al. 2000:118).

According to this, the variation in Eldon types, particularly Angled and Classic Eldon unifaces might represent a similar toolkit.

Tools used in hide processing have convex edge plan views (Brownlee 1995). These edges are likewise blunt. Convex edged scrapers from British Columbia had perhaps two functions: hide working and fish processing (Rousseau 2004:25). Perhaps the direct relationship between edge morphology and tool function cannot be taken at face value. Also, the possible overlap of tool function and distal shape might reflect multiple functions for Eldon unifaces since it appears that the shape of a tool may not be as critical to its function as some archaeologists would like.

Edge Width

Width of a working edge can relate to a specific task. How much surface area a tool works is dictated by how wide that tool’s edge is (Moore 2004:70). A tool with a larger surface area would be better for tasks that do not require attention to detail, like the

felling of trees, as there is less control in using larger tools; paint brushes are analogous to this as it is the smaller brushes that are used for detail but the larger ones for blocking in colors /shapes. Perhaps the difference in Eldon uniface sizes, such as between the assemblages of Aitkow 3 and the Gowen sites are a manifestation of this.

Another possibility is that tools with smaller edge widths might be related to working softer materials. For instance, when the edge widths differed between 5.3 and 8cm, the European axe blades did not have a noticeable affect in felling trees (Mathieu and Meyer 1997:337), but this may not be the case for other woodworking tasks. Scrapers used to process hides and salmon have distal widths over 2cm and tools specifically for hide processing were better suited with edges over 2cm wide (Rousseau 2004). This would reason that tools with edge widths of over 5cm were used for working hard materials, and those with edges below 5cm were used to work softer materials. Again this might be represented in the difference between the Eldon unifaces of the Gowen sites and the Aitkow 3 site.

Task and temporal constraints may have influenced the lengths of Eldon unifaces (eg. Morin 2004). The length of a tool can be a type of morphological or material constraint because only so much of a tool can be used for any give task as material is removed during resharpening sequences (Kuhn 1996). The time it takes to process a material is also a type of task and temporal constraint. The quantity of processed material is moreover a type of task and temporal constraint. These constraints are also interrelated because the more material to be processed, the more a tool will need to be resharpened. The type of processed material further affects temporal constraints because harder materials will take longer to process and will produce more wear on a tool's edge than softer materials. It is likely, therefore, that a tool's morphology and material type will to some degree reflect these constraints. In respect of these constraints, ideally materials would be processed by tools of comparable rigidity /durability.

For the working of a large amount of hard material, a larger tool with a wide distal end and composed of a hard non-brittle material would likely be chosen over a tool with the inverse attributes. Nonetheless, Classic Eldon unifaces are long, have relatively wide distal edges, and are composed of a hard and non-brittle lithic material. While the length of a tool will decrease with continued resharpening, the width of the working edge

should not decrease. This width may originally have been chosen for a particular task and should reflect the amount of surface area that the tool could work. However, a flat distal edge shape would be flush against a worked material while a *u* shaped distal edge would not have the entire edge set against the worked material. Instead, a *u* shaped tool edge would only utilize its entire surface area when the material is pliable and could bend into the shape of the tool's working edge. If there is evidence for working along the entire working edge of a *u* shaped working edge then either the material being worked was pliable or the tool was moved in a rolling direction –this is not the case for Classic or Corner Eldon unifaces as the worn portion of the distal edge does not extend over the entire edge.

The Case for Eldon Uniface Function as Based on Edge Morphology

Classic Eldon unifaces have distal widths averaging 4.9cm, and split pebble tools are significantly different from other Eldon types in their average distal widths of 3.2 (see Table 5.2); it should also be noted that the average width of Classic Eldon unifaces from the Gowen site is 3.8cm. Considering what has been previously presented for woodworking and hide processing tools, such edge widths would indicate that split pebbles were used to process hides, while Eldon unifaces types, in particular the Classic type, were used for woodworking. Likewise for other previously discussed aspects, edge thickness and shape recommends a woodworking function for the Eldon unifaces, in particular the Classic type, but not for the split pebble tools. Nonetheless, such morphological arguments may not act as a rule for interpreting artifacts, especially when Eldon unifaces have no reference in ethnographic accounts. Nonetheless, this is one line of evidence that can be used in reference to the usewear research presented in the next chapter along with the next section's discussion on function from the perspective of edge resharpening, angles, and the possibility of hafting.

5.2.2 Edge Angles

Edge angles might be correlated to a task. Certain edge angles are more effective than others for certain tasks. Acute edges, for instance, dull faster than obtuse edges, no matter what the tool was used for (Tringham et al. 1974:180). Acute and obtuse angles were divided roughly above and below 65 degrees by Vaughan (1985:22). As the angle

increases, so does the force required to use the tool (Odell and Odell-Vereecken 1980:107). Analysis of edge angles led to a set of questions posed by Wobst (1999). These questions illustrated the importance of understanding edge angles for they may imply more than just function:

“In that way working edge mechanics are inseparably interwoven with social dynamics, even in perfectly *functional* aspects of artifacts. The relative functionality of the working edge interferes with, modifies, constrains, rebels against, or reinforces the model that future artifact makers will employ –in making the given kind of tool, in thinking about toolmaking, and in thinking about the social field. To what degree do working-edges approximate the functional ideals? Is working edge form continuous across the possibilities, or does it grade without interruption from one use function to the next one? Are some kinds of edges confined to given kinds of matter? Are some edges taboo for some matter, whereas others are multimaterial? Such questions expose the social dimensions of working-edge variance –dimensions that are not exhausted in energy-matter explanations. Working edges help to constitute, constrain, or alter the social field, whether or not the makers or users are conscious of it.” (Wobst 1999:126)

Frison (1968:150) was the first archaeologist to consider the effects of tool resharpening on edge angles when he examined an assemblage of scrapers at a 16th Century Wyoming bison-processing site. He considered that specific edge angles were maintained throughout an artifact’s use-life; however, Frison did not indicate what angle that was. Dibble disagreed with Frison, arguing that “as [tool] reduction continues, the angle of the retouched edge, or ‘axis of the tool’, changes relative to the axis of flaking” (Dibble 1987:113). Andrefsky (1998) also disagreed with Frison, noting that edge angles changed over the course of multiple resharpening episodes. If this is true for Eldon unifaces, then edge angles within the proposed types should change as the tools are reworked. Figure 5.7 depicts this test in Classic Eldon unifaces. This chart indicates that while lengths may change, the range of edge angles do not. Edge angles range between 45 and 80 degrees, but there is no discernable pattern to suggest a change in edge angles that might correlate to a shrinking length as a product of continued edge resharpening.

There is additionally a lack of standardization among researchers in how edge angles should be measured and how to interpret such measurements; for instance where to place the *cut off* point between one number that is characteristic of wood versus hide working. Some of the task associated edge angles are listed in Table 5.3. This Table illustrates that the correlation between edge angles and tasks cannot be understood as

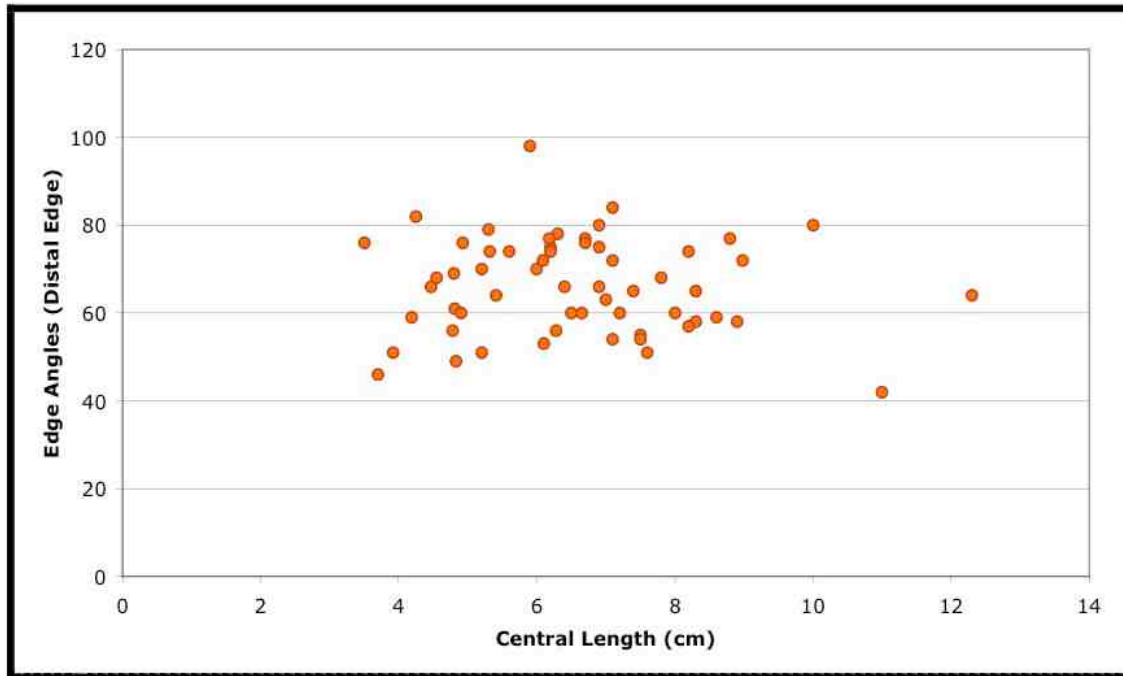


Figure 5.7 Central lengths of Classic Eldon unifaces as compared to distal edge angles to test if edge angles changed from resharpening, as suggested by Andrefsky (1998).

universal. Within some of the referenced studies in Table 5.3 are disagreements. The Black Earth assemblage from Illinois was one such study where the author, Jefferies had the artifacts analyzed by Keeley (Jefferies 1990:10). This analysis entailed a usewear analysis and previous to the study Keeley supposed the artifacts had been used to plane or adze wood, as suggested by edge angles. The usewear results disproved this assumption and instead revealed a hide processing function.

Bone & Woodworking

Mansur (1982:216) wrote that more damage occurred to thinner rather than thicker edged tools used to work hard materials. Shallow edged tools are thinner, so more obtuse angles would be ideal for working hard materials, according to Mansur (1982). This argument is supported by the sharp and steeply beveled spall tools that were used to behead salmon on the Northwest Coast, British Columbia (Morin 2004). These tools were made from quartzite and found to work better than tools with a blunter edge. The density

Table 5.3 Edge angles with associated task, according to the literature.

Table 5.3			
Author (Culture or Region)	Hide Working /Scraping	Wood	Bone /Antler
Belitz 1974 (Sioux)	45	N/A	N/A
Driskell 1986	60+	N/A	N/A
Andrefsky 1998	75-90	N/A	N/A
Gallagher 1977 (Ethiopia)	125	N/A	N/A
White 1968 (New Guinea)	N/A	80-100 (planing action)	N/A
Weedman 2006 (Ethiopia)	50-67	N/A	N/A
Binneman and Deacon 1986:228	N/A	45+ (chisel action)	N/A
Odell 1981 (Dutch Mesolithic)	Less than tools used on harder materials.	More than tools used on softer materials.	More than tools used on softer materials.
Nissen and Dittmore 1974a:70 (Alaskan Inuit)	49-69 (mean of 58, standard deviation 6)	N/A	N/A
Wilmsen (1968) & Hayden 1979 (Alaskan Inuit)	55-100 degrees, mean of 76.4 degrees (Wilmsen 1968; Hayden 1979)	66-75 degrees (Wilmsen 1968; Jeffries 1990)	66-75 degrees (Wilmsen 1968; Jeffries 1990)
Jefferies 1990:10 (Black Earth site, southern Illinois)	73.6 degrees	N/A	N/A
Linnamae 1998 (Heron Eden Site, SK)	35-45	65-85	65-85

and hardness of the lithic material lent itself well to working hard materials like bone or wood (Hayden and Nelson 1981). Similarly, tools with a “very steep and undamaged edge” were suited best for working wood (Grabert 1979:173). Wood working adzes from Manitoba also commonly had steeply beveled edges (Brownlee 1995). In contrast, in a study of Bronze to Iron Age woodworking tools in England, Sands (1997) disregarded edge angles as a factor in a tool’s suitability for working wood.

White (1968) made associations between woodworking tools with high-angled edge-bevels, and hide working tools with shallower edge angles. These tools were from traditional societies in Papua New Guinea where the majority had edge angles of 80 to 110 degrees -Figure 5.8. The weights of the tools were furthermore recorded and have been added to a scatter-plot chart created here in Figure 5.9. The data from White’s research were compared to edge angles and weights of Classic Eldon unifaces –Figure 5.10. There appears to be an association between White’s study and this one in that one

edge angle was more common; however, this angle is slightly lower than that recorded by White. As shown in Table 5.3, edge angles have had various associations with types of worked materials, but the pattern of Classic Eldon uniface edge angles is similar to that of White's and those from the Black Earth site (Jeffries 1990). This might indicate that Classic Eldon unifaces were used to work a hard material such as wood if the correlation between edge angle and type of task holds true.

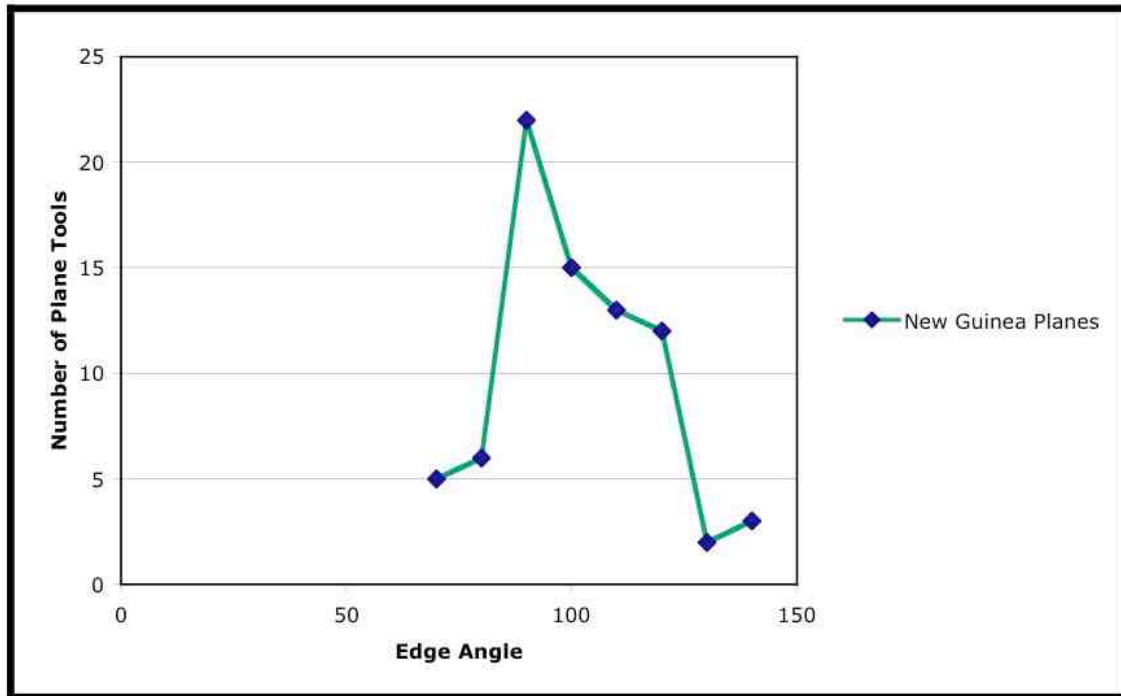


Figure 5.8 Recorded edge angles from planer tools used by New Guinea aboriginals (modified from White 1968:512).

Hide Working

As mentioned in the previous chapter, the Sioux and Nakota groups used two to three hide working tools: for the Sioux it was a hafted scraper called a *wahintke* and an unaltered stone (Belitz 1974), and for the Nakota groups it was a stone /metal scraper, pumice stone, and an elk metapodial de-flesher (Deing 2000:146). The Nakota elk metapodial was used to clean the skin by removing flesh and membrane (Deing 2000:146). A scraper thinned the hide once dried. The scraper's edge angle was not recorded but other dimensions were: 3.5 inches long, 11.5 inches wide, and 1/8 inch thick

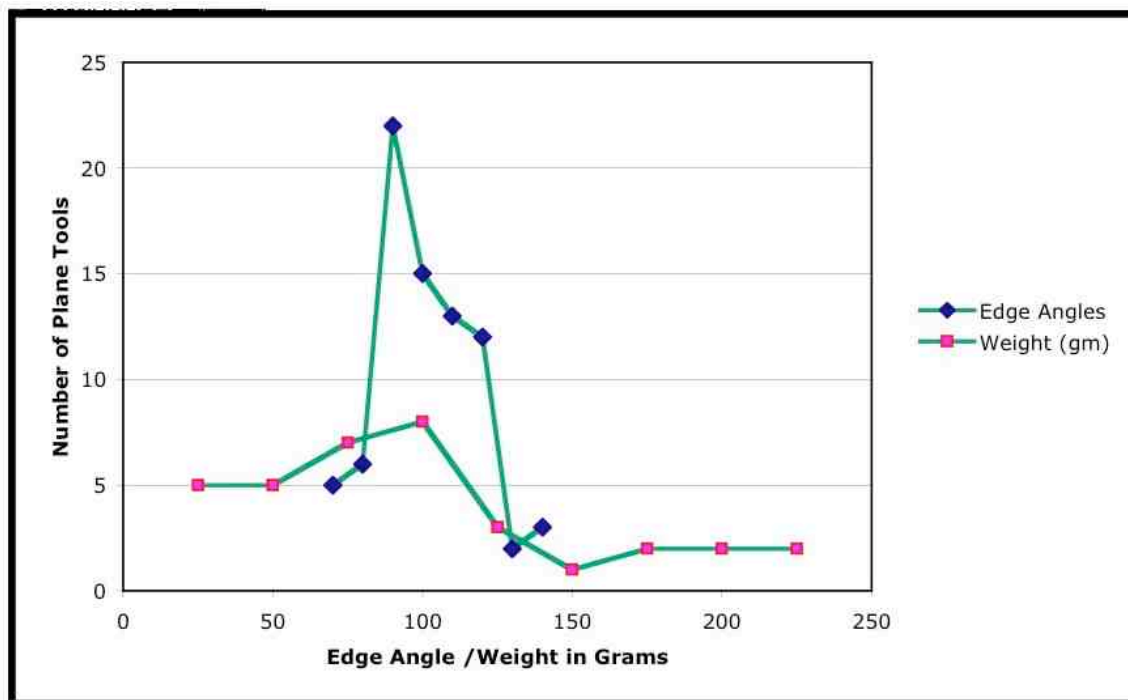


Figure 5.9 Comparison of edge angles versus weights of planer tools recorded in a New Guinea aboriginal group (modified from White 1968:512-514).

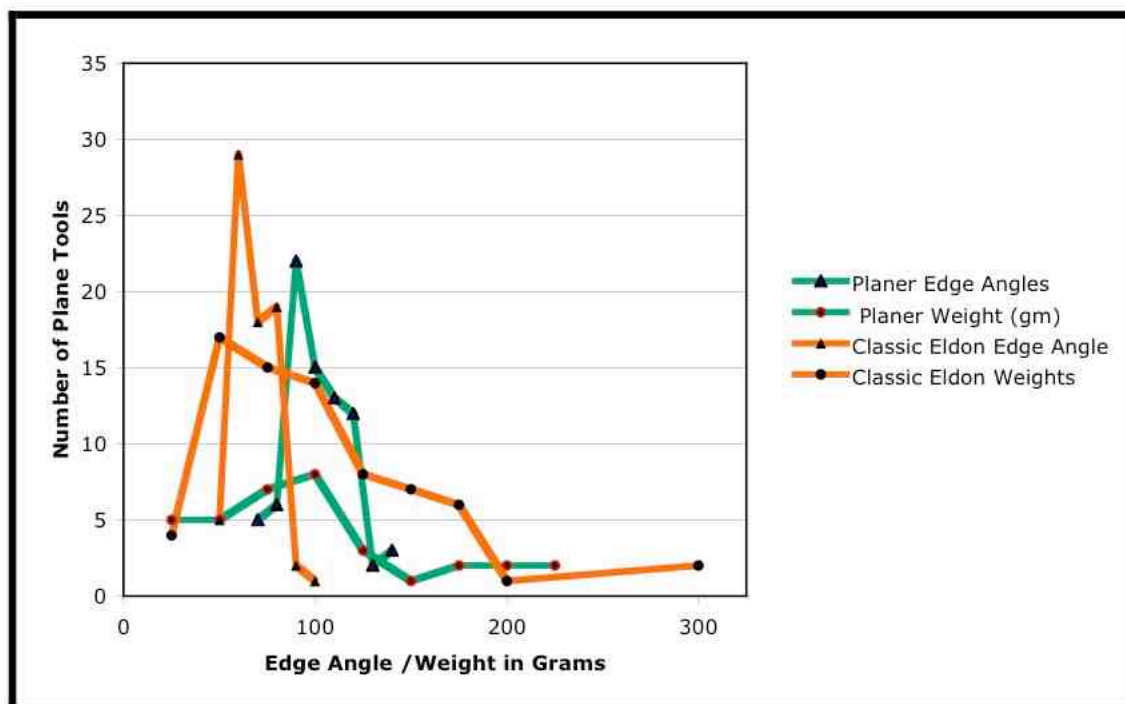


Figure 5.10 Comparison of Classic Eldon unifaces versus New Guinea Planers for their edge angles and weights.

(Deing 2000:147). These measurements pertained to the metal scraper. The Sioux metal scraper was furthermore “tied on a handle made of elk’s horn, cut off at one of the forks, so as to afford a projection to fasten it, being held in both hands” (Denig 2000:147). The Gros Ventres of the Northern Plains also used a similar type of hafted scraper and the process /steps of hide processing were also grossly similar although there was no mention of an unaltered or pumice-like stone used for braining or any other step (Flannery 1953: 70-72).

The cobble spall tools from British Columbia were assigned a number of functions, but a Tahltan ethnography specifically mentions their use during hide dressing. These tools shared many morphological similarities with Eldon unifaces. The length, width, and thickness for 28 of these tools were recorded: 11.7cm in length, 7.4 cm width, and 2 cm thickness (Albright 1984:58). The average of these measurements was larger than that of Eldon unifaces, specifically the Classic style; see Table 5.1 for averages of the Eldon uniface measurements. However, the ratio between the measurements was similar to Eldon unifaces. In addition, Kuhn (1992a) indicated that core size affects the size and morphology of a tool. The Tahltan tools were made from basalt cobbles that might constrain the size of the tools.

The working of Sioux hides was a long process consisting of nine-steps (Belitz 1974). The third step was to de-flesh the hide. This entailed removing flesh and fat with a flaked stone scraper (*wahintkes*), described as very sharp with an edge angle of 45° (Belitz 1974:6-7). This angle differs from contemporary Ethiopian groups who use 125° angled scraper edges (Gallagher 1977:410) (see Table 5.3 for other differences). There was no mention of resharpening *wahintkes*, but the edge angle was discussed as an absolute during any usage of the tool, much like Ethiopian scrapers. Similarly, no edge angles were recorded in Hayden’s usewear analysis on Inuit scrapers. However, Hayden usefully quoted ethnographer, Mason (1891 in Hayden 1979:225) who had witnessed the usage of tools to work hides by the northwestern Eskimo:

“Scraper blades among the northwestern Eskimo are made from a plano-convex spall of black chert, jasper, etc., kept flat on the under face and chipped into shape on the upper face. The cutting edge is rounded and chisel-shaped, and is usually the broadest part of the blade. The general outline varies from circular, or even a flattened ellipse through infinite varieties, to an

oblong parallelogram rounded at either end. Indeed, one and the same blade may be all of these forms at various periods of its existence.”

Furthermore, the *wahintke*, is similar to Murdoch’s 1892 recorded description of Inuit scrapers (*ikuns*) (In Hayden 1979:225). His description went as follows:

“For removing bits of flesh, fat, etc., for a ‘green’ skin, and for ‘breaking the grain’ and removing the subcutaneous tissue from a dried skin, the women, who appear to do most if not all of this work, use a tool consisting of a blunt stone blade, mounted in a short, thick haft of wood or ivory, fitting exactly to the inside of the hand and having holes or hollows to receive the tips of the fingers and thumb. The skin is laid upon the thigh and thoroughly scraped with this tool, which is grasped firmly in the right hand and pushed from the worker. This tool is also used for softening up skins which have become stiffened from being wet and then dried.”

Ethiopian cowhide scrapers were resharpened roughly every 100 strokes, otherwise the tools developed uneven distal edges that could ruin the hide (Gallagher 1977:411). However, drawing from BC artifact scrapers, Grabert (1979:173) claimed that hide scraping did not likely occur with tools of specific acute edge angles but rather “a toothed edge formed by retouch” (Grabert 1979:173). Nonetheless, resharpening may have occurred more or less often depending on the lithic material as their hardness differs and correspondingly, their rates of wear likewise differ. For Ethiopian scrapers, every hour of tool use and edge rejuvenation event produced approximately 1cm of edge removal. Such a rate of reduction would result in a very short use-life for the Gowen site assemblage of Eldon unifaces, which are the smallest collection of the artifacts with an average length of 4.6cm (~5 hours of use) for Classic Eldon unifaces and 3.8cm (~4 hours of use) for Corner Eldon unifaces; however, it needs clarifying that the Ethiopian scrapers were made from chert, which wears faster than quartzite. Furthermore, at least 4 scrapers were needed to work one cowhide due to the rate of tool attrition. A bison’s hide is larger than that of a cow and if Eldon unifaces were used to scrape hide, then their enormous size in comparison to other scrapers would have been an advantage in that not as many replacement tools would be needed. However, endscrapers were still used and likely for hide scraping. In such a case, why would one have two different tools for the same task? It is more likely that while the size of an Eldon uniface would have been beneficial for hide scraping, other factors were not as positive and so, instead, the

endscrapers were used for hide scraping and Eldon unifaces were used for a different task.

Driskell (1986:92) argued for a common hide scraper edge with angles greater than 60° , but offered no upper limit. Andrefsky (1998:154-55) also wrote that edge angles suited particular activities. Sharp or acute edges were suited for cutting materials that were soft such as flesh, while edge angles between $75-90^{\circ}$ were better suited for scraping. Andrefsky's reasoning was that shallower angles were more likely to cut a hide than steeper angles. Andrefsky moreover recommended a three-state ordinal scale of edge angles that were less than 30° , angles that range between 30° and 60° , and angles above 60° . However, Andrefsky did not indicate what these three groups implied. These discrepancies place doubt on the presence of a common edge angle used to process hides.

No Particular Task

Ethnoarchaeological studies caution against interpreting artifact function based on edge angles. In these studies, informants discussed tool edge angles as *only marginally* entering the criteria for classifying their own tools (White and Thomas 1972:286).

Archaeological assemblages, also require caution when interpreting artifact function based solely on edge angles. For instance, endscrapers from the Star Carr site, England, had multiple functions and yet had one common edge angle (Dumont 1983). These artifacts were used to process hides, bone, wood and antler. Likewise, Dutch Mesolithic scrapers were used for a variety of tasks such as scraping, graving, chopping and boring (Odell 1981). A third example comes from the Mayan site, Cerros (Lewenstein 1991 in Odell 2001). Edge angles at this site overlapped with tasks "so drastically that one cannot employ edge angle to infer function, even when morphological class is considered" (Odell 2001:51).

The Case for Eldon Uniface Function as Based on Edge Angle

The previous section demonstrated the problematic nature of correlating edge angles with function. Much of the problem revolved around attempts to identify a governing law where angles correlated with function. Such a correlation was at best true for only specific regions in which each study was undertaken. Any association between edge angle and function was likely broader. In particular, it might be that there are large and

overlapping angles that work best for particular tasks, but to use such angles to infer function is problematic. Shott (2002:103) argued that the tip angle of projectile points was related to a tool's use-life. Applying this idea to unifaces would suggest that edge angles are better suited to general tasks that might increase tool longevity. In the case of projectile points, a "high tip angle may promote longevity but perhaps at the expense of performance; points with higher angles tended to last longer because they often bounced off the target" (Shott 2002:103). Shott's argument would suggest that 'appropriate' edge angle provides greater longevity to a tool's life. A projectile's tip angle was similar to a scraper edge angle since both tool forms penetrate a material. In projectile points this angle looked to the tool's top or bottom but for scrapers it was from the side, a difference of perspective (Figure 5.11: The four sides of the tools was compared and shows no discernable pattern. There is a wide range of edge angles, with a spread of thickness from 0.5 to 2cm, revealing that considerable resharpening may have occurred and hence no substantial inference can be made about the tools' usage based solely upon their edge angles). In Figure 5.12, the thickness of the distal edges was compared against edge angles. A clear separation, which should be expected because of material type, between split pebbles and the Eldon forms. Angled corner Eldon unifaces are not included as they have two working edges,. Some Amorphous Eldon unifaces had more than one working edge too, so only what was orientated as the distal edge was considered in this figure. Classic Eldon unifaces, like Figure 5.13, have a slight trend where the edge angle is between 50 and 80 degrees, with an associated distal thickness of between 1 and 2cm. This distal thickness is just shy of the central thickness. The latter is a more accurate reflection of the original flake's thickness, being between roughly 1.5 and 2.5 cm, so there is a slight thinning near the distal edge. While more specimens would be needed to make the argument more convincing, the figure does indicate a slight trend in Classic Eldon unifaces in that their distal widths tend to fall between 4 and 6cm, and they have associated edge angles between 50 and 80 degrees (see Figure 5.14 for further comparisons).

Therefore, based on edge angles, it is difficult to determine a function for Eldon unifaces because much of the literature is contradictory. If one wished to make a general case for function, Eldon unifaces were likely used to work medium-hard materials of

bone, wood, or hide (dried). The mean edge angle is 64° for Classic Eldon unifaces, which might be associated with the working of softer materials. The range of edge angles is 42° to 98° for the 69 Classic Eldon unifaces that retained their distal edges. For Angled Corner Eldon unifaces, the mean edge angle is 70° and 65° for the opposing edges. The range for this type of Eldon uniface is 44° to 83° , and 46° to 86° , which suggests that both edges were fairly standardized. The total number of Corner Eldon unifaces that retained these edges was 10. This might, too, indicate that these tools, especially for the Gowen site were used to work softer materials like hides. When the artifacts are considered for each site they are found to have fairly constant edge angles. This comparison was done for Classic Eldon unifaces as this is the largest sample. Of the three sites with the largest number of Classic Eldon unifaces, the mean edge angles were: Gowen (68°), Upper Lovett Campsite (55°), UofS collection (63°), and Aitkow 3 site (65°) (Table 5.2).

Table 5.4 Edge Angles organized by mean, and arranged by site and total number.

Eldon Uniface Samples	Classic	Corner	Split Pebble
Alberta Boreal	75	n/a	n/a
FgQf-16 (Upper Lovett Campsite)	55	n/a	n/a
Aitkow 3	65	53 /69	n/a
Gowen	68	64 /63	65
EgNn-9 (Sand Hills)	72	n/a	n/a
UofS Collection	63	70 /76	n/a
Pheonix Collection	66	n/a	n/a
Total:	64	65/70	65

Based on mean edge angles, it appears that Eldon unifaces were used for working soft materials, like hide processing. The difference between sites is negligible, except the Upper Lovett Campsite. The amount resharpening had influenced these edge angles is unknown. This inference is contrary to what was implied previously by the analysis of the edge morphology. This indicates that it is problematic to use only morphological characteristics of artifacts to infer their function, not to mention only one aspect of morphology by itself.

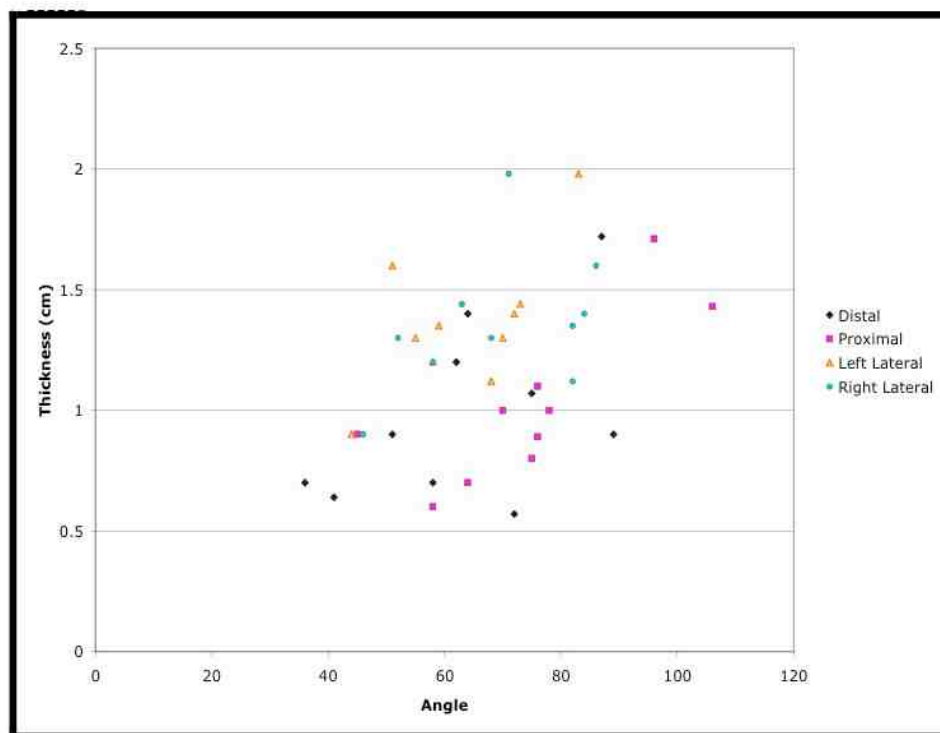


Figure 5.11 Comparison of edge angles and their corresponding thicknesses of Corner Eldon unifaces.

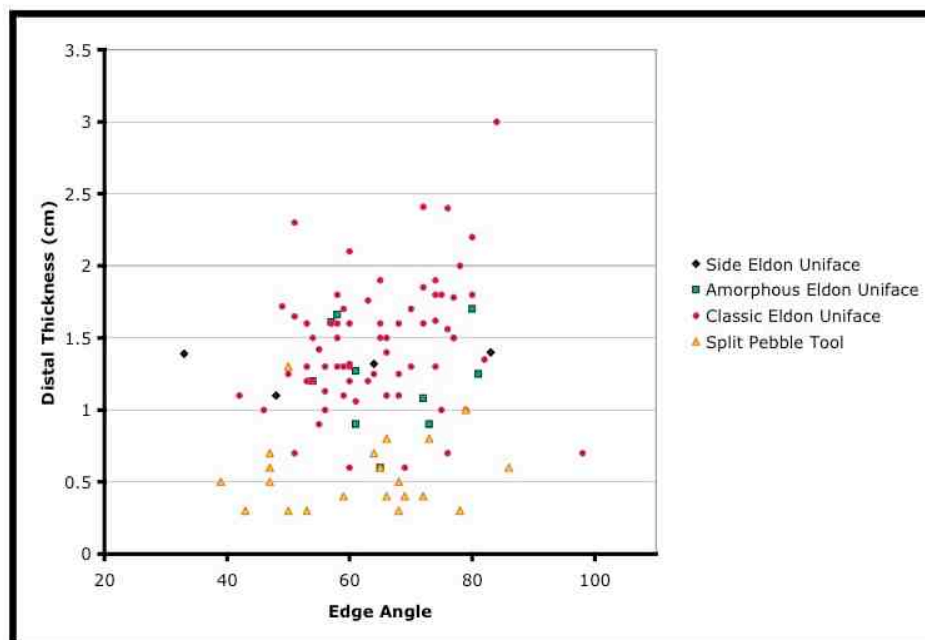


Figure 5.12 Comparison of distal thickness and edge angles according to Eldon type and split pebble tools from the Gowen site.

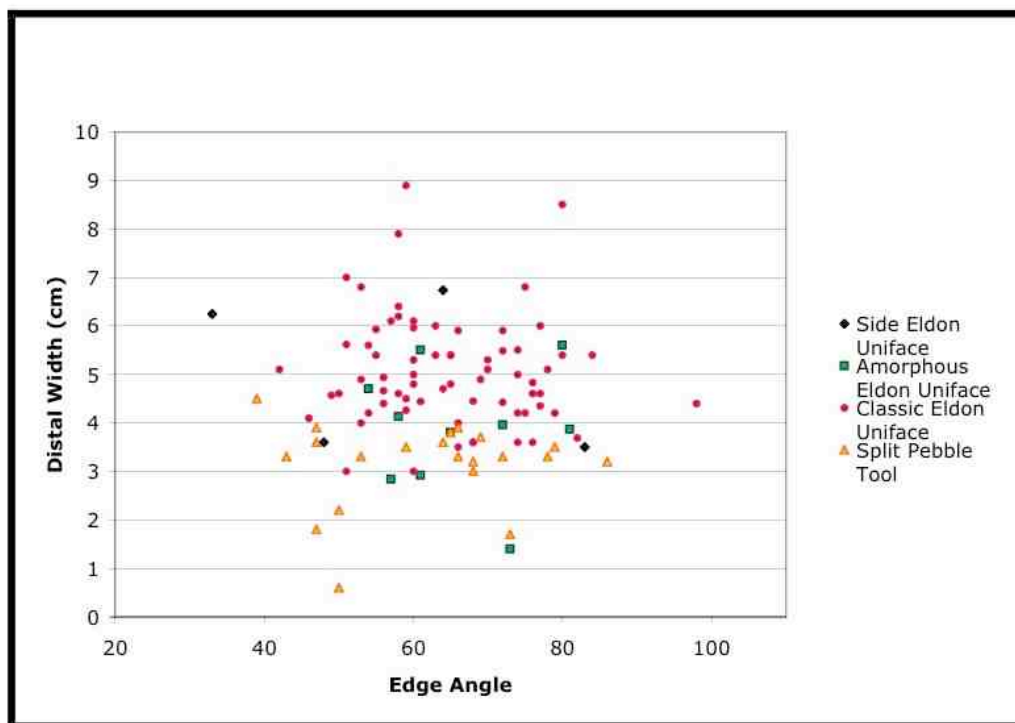


Figure 5.13 Comparison of distal widths and distal edge angles according to Eldon type and split pebble tools from the Gowen site.

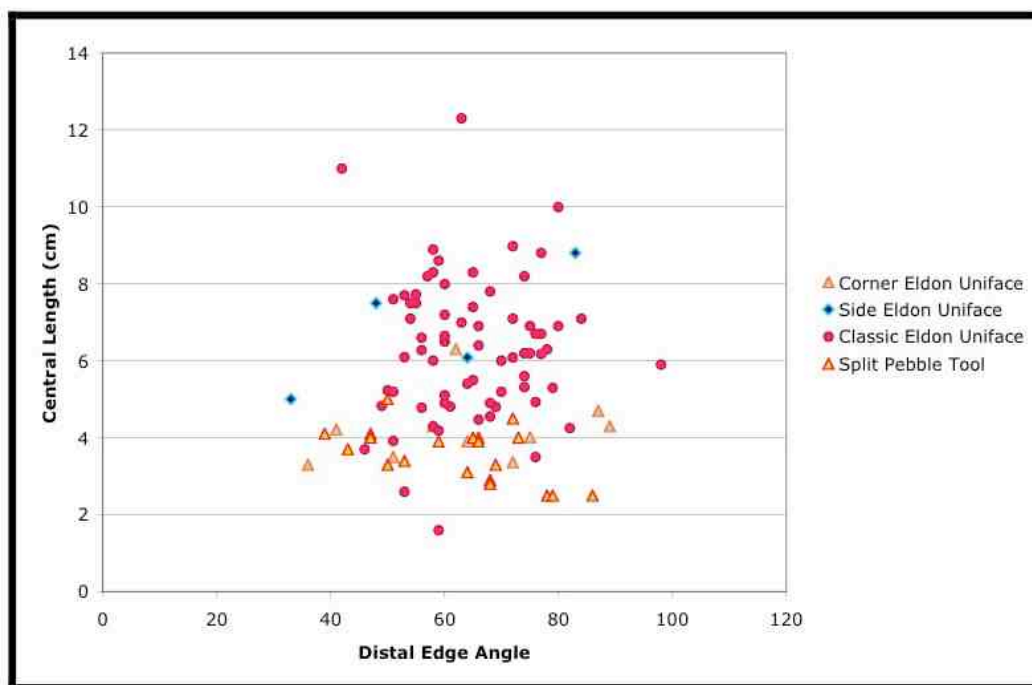


Figure 5.14 Comparison of central lengths (maximum) versus distal edge angles for Eldon types.

5.3 Proximal Morphology: Hafting vs. Prehensile Manipulation

5.3.1 Hafted Tools?

Little is known of Precontact tool handles in North America because they were made from organic materials, which have disappeared due to taphonomic processes (Weedman 2006). Without direct evidence to suggest if Eldon unifaces were hafted, and what shape the handles took, indirect evidence is drawn from morphology, usewear, and analogies. Analogies are made with known hafted tools from archaeological and ethno-archaeological contexts and from experimental re-creations. Morphology and wear of Eldon unifaces is compared to artifacts known to have handles and similar shapes and wear patterns. Handles are additionally discussed; in particular, why they were used and their advantages.

Advantage to Hafting

According to Madal et al. (2000), hafting lengthened a tool's use-life. Morrow (1996:587) disagreed and instead indicated that a handle increased the tool's functional efficiency, for use-life was a measure of how much the stone tool was physically exposed and used.

Not every handle and haft was the same and each had their own unique advantages (Mandal et al. 2000). One such advantage was that a handle enlarged a tool, which aided in its identification when placed next to other tool forms and in locating it when left unused (Rousseau 2004:9). Weedman (2006:192) argued that hafts often took more time to construct than the stone tool itself. Despite this, it had the advantage of being used for a long period of time, sometimes for generations.

In Papua-New Guinea, small stone tools were more easily used and greater leverage was allowed by the addition of a handle (White and Thomas 1972:286; Morrow 1996:587); further, small hafted tools were differentiated from one another, unlike unhafted tools. In general, hafting of smaller tools allowed for greater detailed work and better control on application of force (Rousseau 2004:9). Some specific types of tools such as projectile points, axes, and adzes, also required handles for without them these tools could not be used effectively (Morrow 1996:587). Greater force was important when working harder materials such as wood or disarticulating animal carcasses

(Mathieu and Meyer 1997:349; Andrefsky 1998:163). For axes, longer handles were more efficient for working larger materials such as trees, as longer handles granted slower swing rates that were more powerful. On the other hand, shorter handles were better suited for delicate tasks like cutting or shaping wood (Moore 2004:63). Handles in general allowed for “heavier and more exacting force loads to be exerted both on working edges and on the materials being worked” (Rousseau 2004:5).

Hafting effected the behavior behind lithic technologies. For instance, hafted tools reduced “the weight of personal tool kits” (Rousseau 2004:5), which must have been important to Northern Plains mobile groups. The curation of hafted tools decreased the toolkit weight. This reduced the amount of lithic raw material that was needed on a daily basis. As well, only one handle was needed since it could be used for multiple stone tools as they were recycled /replaced (Rousseau 2004:7). Odell (1994) too argued that hafting increased as people became sedentary and logistical forays became more common. These forays entailed an element of risk in which more reliable tools were required and hafting was one way to make tools more reliable.

Description of Handle Types: Open vs. Closed-Socket

There are many different types of stone tool handles. Handles can be shaped according to cultural tastes and reflect the identity of the group or individual (Weedman 2006:192). There are also differences between handles due to their varying functions.

Two simple morphological features can organize handles: open and closed sockets. A closed socket is where the tool is attached to a surface of the handle. For example, tools used for woodworking often have dorsal surfaces touching the handle (Rots and Vermeersch 2000:157), as with adze blades from South Africa (Jerardino 2001:859). These South African tools were also secured with mastic at the top of the handle.

With an open socket, the tool enters a portion of the handle. Projectile points have three different forms of open socket hafts: a) split and wrapped foreshaft, b) socketed and wrapped foreshaft, and c) carved and wrapped foreshaft (Plew and Woods 1985:220). Although this is specific to projectile points, this might apply to Eldon unifaces as there is nothing to indicate that these hafting strategies were exclusive to projectile points.

Juxtaposed hafts were sometimes used for woodworking tools. This type of haft had “the tool...placed distally in a transverse direction with the active part oriented perpendicularly” (Rots and Vermeersch 2000:157). The Gamo of Ethiopia had another style of open-socket haft where a scraper’s handle was constructed from wood with one end split open to receive the stone tool (Weedman 2006:201). The scraper could also be “wrapped in a piece of cloth or hide shaving or wedged with a piece of wood and inserted into the split end of the wooden handle” (Weedman 2006:201). Rope was then wrapped around the split to further secure the stone scraper. Open socket hafts also used for South African hide processing scrapers (Weedman 2006). These scrapers were inserted into a carved hole on the side of the handle at 90° (Jerardino 2001:859). Resin was then spread across the area to secure the fit.

Material

A tool’s handle can be made from wood, bone, or antler. Wood, for instance, was a common material used in the boreal forest of Manitoba (Malasiuk 2001:31); however, it was sparser in the Alberta and Saskatchewan prairies and may not have been used as frequently as it was in Manitoba. Antler was additionally used for handles. Eldon unifaces, except for those from the Gowen site would be too large for an antler handle. In respect of the Gowen artifacts, different animal species from the Northern Plains that were procured for subsistence purposes had antlers that may have been used for handles. Of the antler bearing species in Saskatchewan elk, mule deer, moose, and caribou would have all been available in various regions throughout the province (Fung 1999:141). As mentioned previously for Nakotagroups, elk antler was the material of choice in scraper handles (Denig 2000:147). The Gros Ventres used short handles, but Flannery (1953:71) did not indicate what they were made from.

Bone too was used for handles (Hayden et al. 1996b; Rahemtulla 2003), and this material may have been large enough to haft Eldon unifaces and was more plentiful than wood. Not all species of animals would have possessed bones of sufficient size to be used as handles but animals such as the pronghorn, elk, mule deer, moose, caribou, bison, black bear, and various members of the Canidae and Mustelidae families could have sufficed (Fung 1999:141).

Resins, Mastics & other Bindings

There were many different types of materials used to secure a tool in its haft. Like the handle, these materials are almost never preserved due to their organic composition. One known organic material used to secure tools was resin. A resin is a sticky substance from plants and trees (mastic). This sticky material was used across the world including Queensland Australia (Moore 2004) and Ethiopia (Weedman 2006:199). Birch tar was another mastic widely used during the European Mesolithic and Neolithic periods as suggested through recently applied techniques such as residue or chemical analysis, SEM analysis, and EDAX analysis (energy-dispersive analysis of X-rays) (Pawlik 2000). Birch tar from Mesolithic-Neolithic Europe was heated prior to use, and it acted not only to secure the stone, but also absorbed shock during tool use. How European birch tar was heated is unknown, but Pawlik (2000:179) suggested that birch bark was rolled into a cylinder with heated pebbles and clay that melted the tar. During the later Ceramic period, small clay pots were used to melt plant tars /resins.

Rope /cord was another organic material used to secure hafts, as noted with Ethiopian tools (Weedman 2002:733). Leather had, too, been used to secure tools and worked as a shock-absorber (Rots and Vermeersch 2000). When attached and left to dry, leather becomes stronger than if standard (supple) worked leather was used (Rots and Vermeersch 2000:157). Shock from tool use can chip or break the tool's proximal region, but the insertion of wood into the haft and securing with rattan, as was documented for traditional groups in Irian Jaya, would reduce this damage (Stout 2002:700).

Bitumen is an inorganic material used to fasten tools in their handles across the world. It was readily available in the Near East (Anderson-Gerfaud 1988). Bitumen was used during the European Middle Paleolithic (Weedman 2006:192) and a combination of pitch and black tar was used for open-socket tools in Ethiopia (Gallagher 1977:411). Northern Alberta aboriginals similarly used bitumen to patch canoes (Fenton and Ives 1990) and perhaps to affix stone tools to their hafts. Unlike artifacts from the Near East (Anderson-Gerfaud 1988), no bitumen has been found attached to Eldon unifaces from the Alberta boreal forest nor any other organic traces (Laura Roskowski, personal communication 2008).

Hafted tools attached with mastic tend to snap in their handles unlike hafted tools without mastic that slip out instead (Weedman 2006). Hafted tools likewise receive damage to their proximal areas during use, as explained previously. This damage differs according to the type of mastic that was used as some can have a grainier texture that promotes striations forming. Others can be weaker and allow the tool to shift in the haft resulting in chipping and other forms of wear (Nissen and Dittmore 1974b; Odell & Cowan 1986:204). The users of stone tools likely recognized these differences amongst mastics, so specific types of mastics were sought that would produce less damage to the inserted tools. Resin conjointly distributes the load /force during tool use more evenly than is the case without a resin (Moore 2004:70). Aboriginals from Queensland Australia made certain that the stone tool was coated with resin and did not contact the handle (Nissen and Dittmore 1974b; Moore 2004:64).

Alterations to the Tool

Evidence for stone tool hafting can be identified through microscopic and macroscopic forms of investigation. Hafting requirements result in a regularization of stone tool manufacturing (Odell 1994:54). Such modification results in a standardization of overall design (Odell 1994:54). The production of a hafted tool is time consuming since the blade must be carefully knapped and then it must be attached to its handle. Because of this increased time and effort the tool is more likely to be curated. Odell (1994:55) argued that curation in this sense also entailed increased transport distance of a tool, since now this tool would likely be used repeatedly and hence carried with an individual over time as (s)he may require to use it.

The proximal parts of hafted and unhafted tools commonly differ. Measurements of the length of area covered by a possible haft and this part's width and thickness can indicate if a tool had been hafted (Andrefsky 1998:165). Differences in the proximal and distal width and thickness can also suggest hafting. Hafted tools are commonly smaller in size, thinner, and narrower in comparison to unhafted tools (Plew and Woods 1985:220). The difference in widths can often give the artifact a tapering appearance. This is why for Eldon unifaces measurements were recorded at three spots, the distal, middle, and proximal sections (Figures 5.15 to 5.18). Figure 5.18 depicts the measurements of all

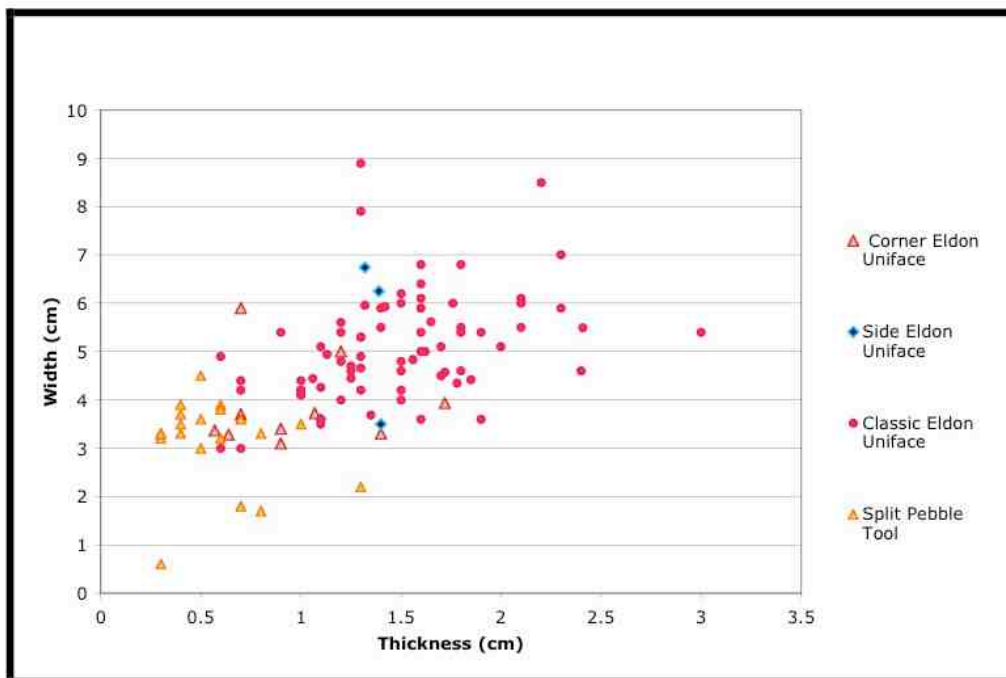


Figure 5.15 Comparison of the width and thickness at the distal part of Eldon unifaces. Data is separated by type.

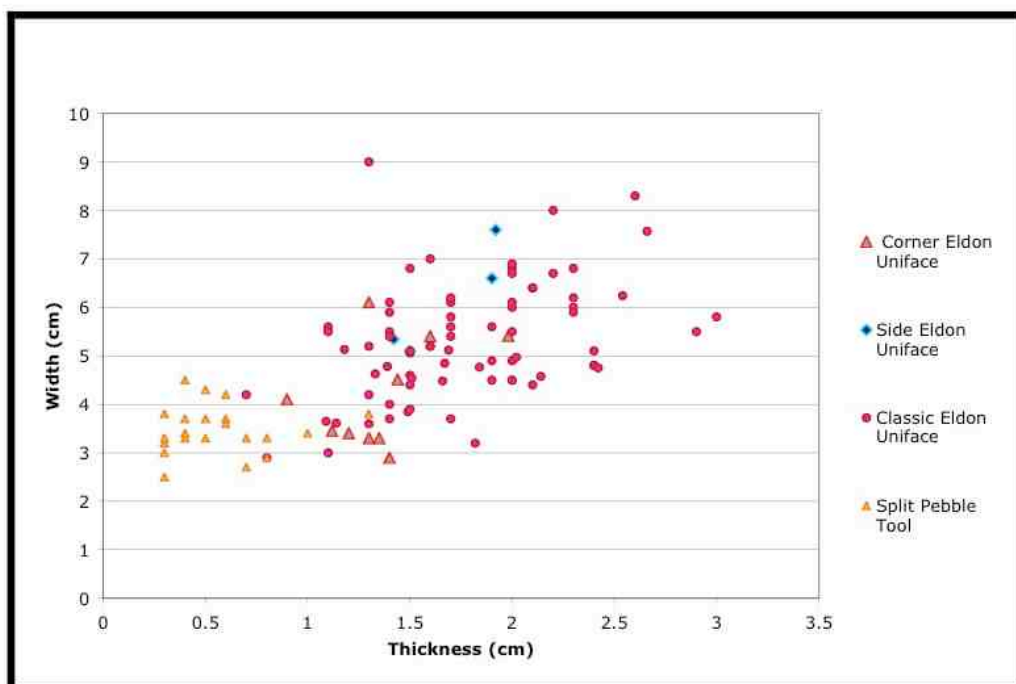


Figure 5.16 Comparison of the width and thickness at the central part of Eldon unifaces. Data is separated by type.

three areas, for all four types. It appears that what Andrefsky (1998) and Plew and Woods (1985) had reasoned for evidence in hafted tools holds true for Eldon uniface types; they were likely hafted.

Grinding and dulling of an artifact's proximal edge can conjointly be an indication that it was hafted (Julig 1994:28; Andrefsky 1998:22). Tool edges are blunted so they do not cut into the haft or lashing. Projectile points and knives commonly have notches along their proximal regions that add increased stability through lashing between notches; some however have argued that notches are not a function of hafting but rather a cultural preference (Rousseau 2004:6).

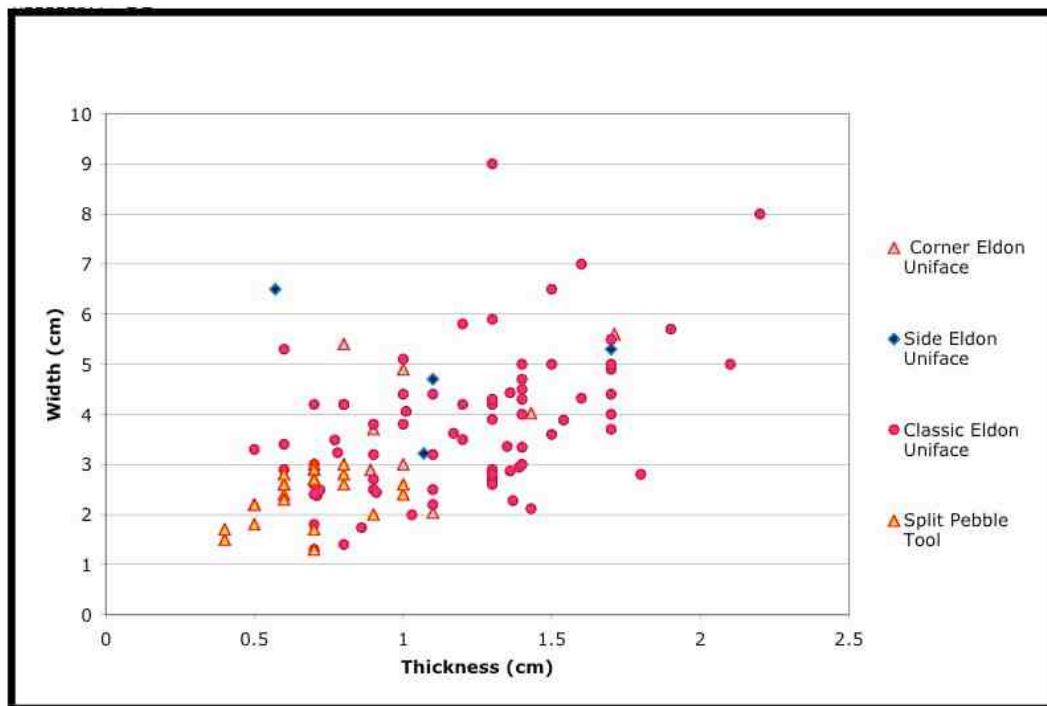


Figure 5.17 Comparison of the width and thickness at the proximal end of Eldon unifaces. Data is separated by type.

Use Evidence of Hafting

Hafting produces more wear on a stone tool than prehension (Odell 1981; Andrefsky 1998:163). However, a good haft should not leave substantial wear on a tool as it limits the amount the tool will move in the haft (Moss and Newcomer 1982; Vaughan 1985:39; Jensen 1988:79; Rots and Williamson

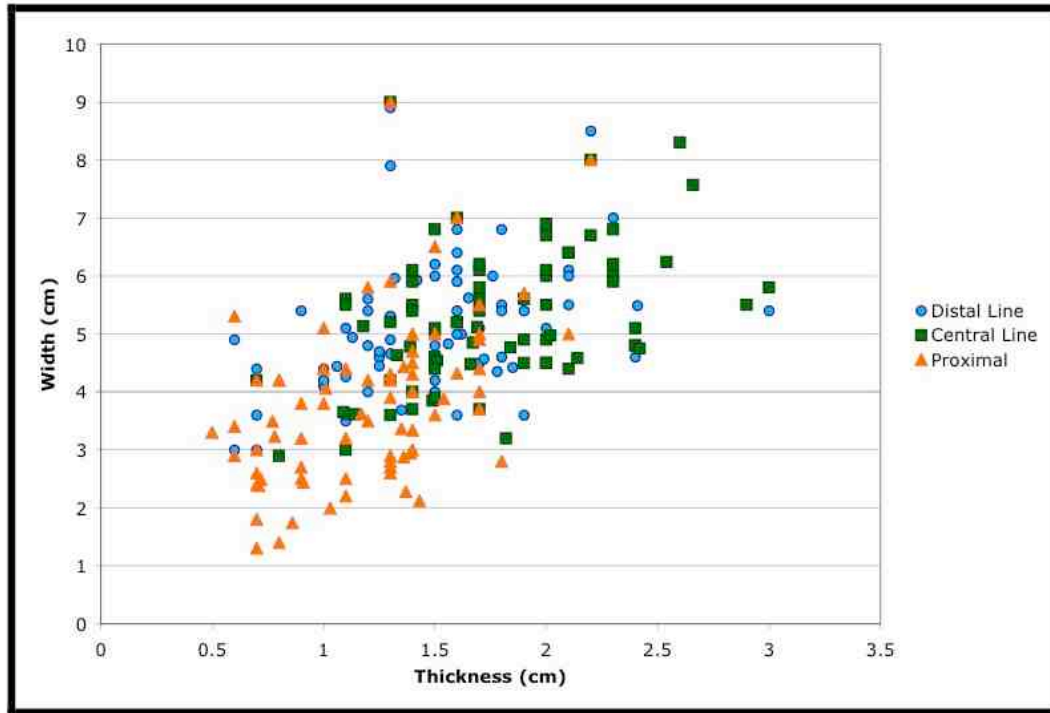


Figure 5.18 Comparison of the width and thickness at the distal, central, and proximal sections of Eldon unifaces. Data represents all four types of Eldon unifaces.

2004:1288; Lemorini et al. 2006). As well, a tool's morphology influences hafting wear (Rots and Vermeersch 2000:160). For example, well-developed wear will appear when a tool has a triangular or trapezoidal cross section that rubs against the surface of the haft (Rots and Vermeersch 2000:160). Three types of tool cross-sections are shown in Figure 5.19. Eldon unifaces have an ovoid cross section that develops less wear.

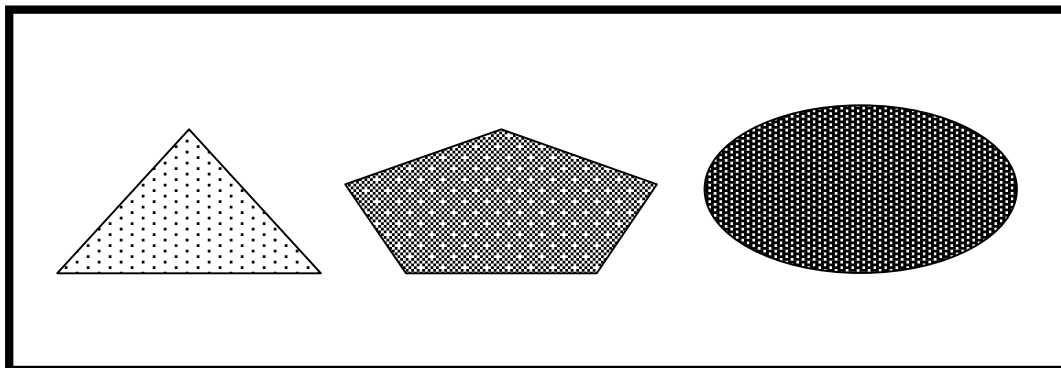


Figure 5.19 Three cross-section shapes of hafted tools: triangular, trapeze, and the Eldon uniface shape, oval.

Hafting wear traces come in the “form of minuscule bits of unidentifiable polish on one or two of the ridges or other high points of the microtopography” (Moss and Newcomer 1982:292, in Vaughan 1985:39). Such high-relief polish is found on many of the Eldon unifaces. This polish is sporadic but patterned in the sense that it is isolated to only the proximal half and orientated in a direction that a haft would conceivably move. Haft wear can also come in the form of chips or abrasions along the edges (Odell 1994:60; Linnamae and Johnson 1999:22). Edge chipping is not commonly found on the proximal areas of Eldon unifaces. Edge abrasion is found on Eldon unifaces, but can be mistaken for edge grinding and bashing that was formed during manufacturing. Additionally, dehafting can produce more wear than was made while a tool resided in the haft (Rots and Williamson 2004:1288). In experiments, extracted tools develop polished high-relief areas upon exiting the handle (Rots and Williamson 2004:1291-1292).

5.3.2 Unhafted Tools?

Before it can be argued that Eldon unifaces were hafted, the evidence for unhafted tools (or prehensile tools) must first be offered. Odell (1994) outlined some of the advantages to an unhafted in regards to maneuverability and increased edge area tha can be used for work:

“Using a tool manually allows one to shift the tool around in the hand and use a variety of edges, often for different tasks and sometimes without even being aware of the changes. In contrast, placing a piece of stone in a handle restricts contact of a large portion of that stone to the handle, rendering it unusable for any other task. Therefore, the more frequently stones became employed as inserts or as parts of composite implements, the more functionally limited each piece of stone became.”

“Similarly, encasing a tool in a hafting device would have restricted the quantity of different tasks for which that implement would have been appropriate, so the number of different activities and worked materials /tool would also have decreased.” (Odell 1994:66-7).

Unhafted tools needed to be *comfortable* in the hand, and this need results in macroscopically observable features (Morrow 1996:587). Fresh broken stone, naturally sharp, can injure the hand when held and edges must be blunted or wrapped in something so the hand is not cut; wrapping materials are not handles, as they are not attached to the tool but instead sit atop the tool *only when in use*. Dulling or backing (blunting) a tool’s edges also provides comfort for the hand. Backing has been defined as “an intentionally

dulled edge, accomplished by chipping or from grinding or abrading the edge” (Andrefsky 1998:163). Another approach is evidenced on Archaic (or Middle for Plains prehistory) Period scrapers in the state of Maine that had flat areas opposite the distal edge that functioned as hand grips (Sanger 1996:21). Similarly, cortex on the back of North American scrapers was used as a handgrip (Crabtree and Davis 1968).

Scaling-up a stone tool further aided prehension. This allowed more surface area of the stone tool to be held, providing better control (Morrow 1996:587). Scaling establishes a flaw in Odell’s ideas, in that not all tool edges were available for use because portions of the tool needed to be modified in some way to accommodate *comfortability*. Certainly a used edge can be rotated in the hand but dulling some edges for comfort, again produces a limited use area. This is then no different from hafted tools that were switched in their hafts so the once concealed edge was now sharpened for use and the used edge was inserted into the haft. In essence, there was always a limit on how much surface area was available for use.

5.3.3 Were Eldon Unifaces Hafted?

Were Eldon unifaces hafted? This chapter has presented information for identifying macroscopic and to a lesser extent, microscopic evidence for hafting or prehension of stone tools based on the above information, Eldon unifaces were likely hafted. Indirect evidence had to be used since there are no known examples of Eldon uniface handles. There is also no evidence of mastics or resins. However, morphological features of other hafted tools did match that of Eldon unifaces. As was indicated in Figures 5.16 to 5.19, there was a difference in measurements between distal, central and proximal regions. This was accepted as evidence that Eldon unifaces were shaped to fit a haft, although this shape may in addition have been the natural form of the blank; the tapering proximal end of an Eldon uniface is shown in Figure 5.20. If the blank already tapered towards the proximal region there would be no need to modify this region other than to blunt the lateral edges. Blunting of lateral margins is another sign of hafting because it prevents a tool’s edges from cutting the haft and lashing. Blunting edges is also a sign of prehensile tools for this makes the tool more comfortable in the hand, although, unlike prehensile tools, multiple edges were blunted.

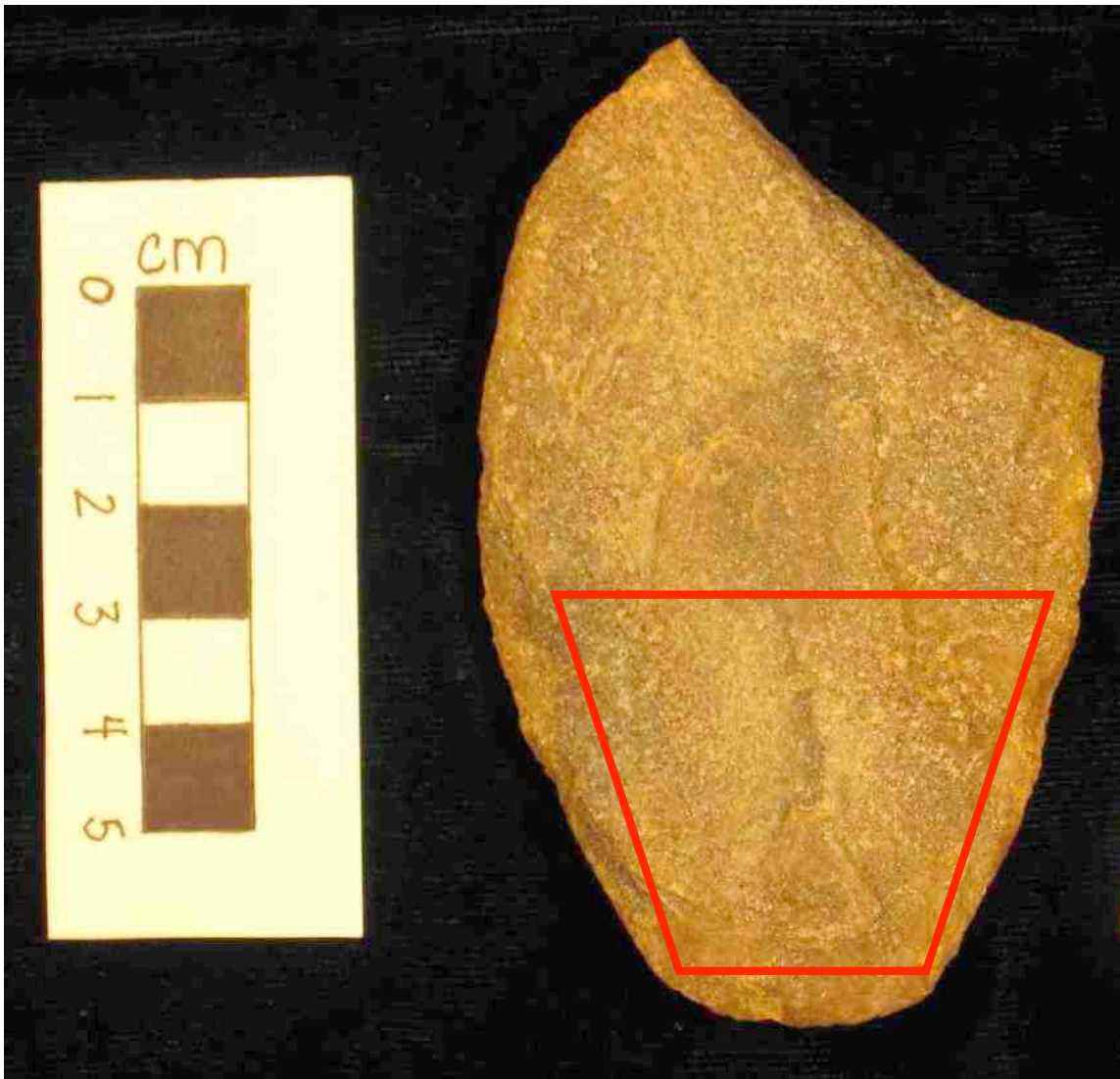


Figure 5.20 Tapering of the proximal end of a Classic Eldon uniface from FgQf-16.

Shorter handles are useful for precision and maneuverability orientated tasks like using adzes to shave, cut or shape materials (Moore 2004:63). Longer handles are better suited for powerful swinging actions in cutting or chopping. This increased power is useful when working hard materials such as wood or bone. The length of handle for Eldon unifaces might have been related to the size of the stone tool itself, implying that artifacts from the Gowen sites had smaller handles than artifacts from the other sites. Further, larger Eldon unifaces were likely used in a closed-socket handle, as they would easily fall out of open-sockets. Smaller Eldon unifaces from the Gowen site may have

been inserted into either an open or closed-socket handle. As discussed previously, these tools were likely used to work hard materials as inferred from edge morphology. Perhaps larger Eldon unifaces were used to cut and chop while smaller versions were used to shave, cut or shape, but all sizes were used to process wood or bone.

The type of material that a handle was made from was influenced by constraints of the natural environment and the size of the Eldon unifaces. For larger Eldon unifaces, wood or bone was likely used; although wood is the favored option as it is more elastic than bone and would function more efficiently in tasks that require substantial force. Antler was too small except for Gowen site Eldon unifaces. These may have been hafted with antler, bone, or wooded handles.

5.4 Conclusion

The dimensions of Eldon unifaces hint at tool function, but a review of the literature on previous artifact metric studies demonstrates considerable confusion on how to interpret such metric attributes. The greatest source of confusion surrounds edge angles. Many authors present conflicting correlations of specific angles with specific tasks. Because of this confusion it is highly unlikely that edge angles can be used to demonstrate a tool's task and the only benefit could result when combined with other methods of analysis such as usewear research. However, attributes associated with hafting are far more reliable. There was agreement in the literature on what constitutes evidence for hafting versus prehensile usage of stone tools; this line of inquiry, like edge angles was additionally strengthened through coupling it with usewear analyses. Because of this confusion it is highly unlikely that edge angles alone can be used to demonstrate a tool's task. The edge angle data must be combined with other methods of analysis such as usewear research.

Notwithstanding the problems of using a morphological approach to indicate a tool's function, based on the information presented in this chapter Eldon unifaces were likely used to work hard materials like wood and bone. The evidence of edge angles, morphology, and likelihood of hafting all point to working hard materials. Although these lines of evidence would seem to agree with each other, some authors would infer the edge angles to be representative of working softer materials. The previous chapter's discussion of the artifact's material type and retention of cortex also suggested a function related to the processing of hard materials like wood and bone. The results of the usewear research

discussed in the following chapter indicate that Eldon unifaces were used to process medium to hard materials. This recommends that morphological analyses are not without their merit, but are strengthened when multiple aspects of a tool's morphology are used and then combined with other avenues of support, such as the tool's material type, comparison to similar tool forms, and of course, usewear studies.

There are differences between Classic and Corner Eldon unifaces found in Saskatchewan and Alberta. The shape of the distal mouths is one such difference. This might be in relation to a difference in function, and as discussed in the previous chapter the style of Eldon unifaces is likely found in morphological aspects that pertain to the tool's function. The difference in mouth shapes might represent iconological style.

In the previous two chapters similarities were drawn between cobble spall tools (CSTs) from British Columbia and Eldon unifaces. These similarities were found in how the two artifact types were constructed. Dissimilarities, though, were found in that the descriptions of CSTs were more homogenous than Eldon unifaces. Classic Eldon unifaces seem to have the closest morphological similarity to CSTs and the Corner Eldon unifaces share similarities with both CSTs and bi-pointed adze blades from Manitoba. In addition, there were a number of different functions assigned to CSTs, in particular hide dressing. This chapter's discussion of Eldon uniface function would imply they were used for harder materials than hide.

Chapter 6

Function II: Usewear

The tool exists only with the gesture which renders it technically efficient.
(Leroi-Gourhan 1965:35 in Stout 2002:694).

6.0 Introduction

Very little remains of past cultures. On the prairies and boreal forest of Saskatchewan and Alberta it is often only the inorganic materials like stone that survive. Stone tools worked these perishable materials and a usewear analysis of these tools can indicate what types of perishable materials these tools had worked and how the materials were worked -cutting or scraping. Stone tools represent the majority of an archaeological assemblage, but ethnoarchaeological studies suggest that stone tools should instead constitute 5-10% of the assemblage (McGovern 1995). Since stone is one of the few surviving remnants of past cultures, it becomes paramount that as much information as possible be derived from stone artifacts. Therefore, usewear analysis is used in the study of Eldon unifaces for it provides a further avenue in understanding both these objects and the people who made, used, and eventually discarded them.

Walker (1992:55-58) originally mentioned Eldon unifaces as possibly wood working tools. This chapter tests this possibility through relating microscopically observed wear traces on the surfaces of the Eldon unifaces with what has been described and interpreted by other usewear researchers. The importance of usewear studies is elaborated below. What usewear analysis is and how it is performed is also explained below (Appendix A outlines the types of wear traces, how they were defined, and what they implied). Following this, a sample of the artifacts from the collections studied here is analyzed for their observed wear traces. These observations are then used to infer what tasks and materials Eldon unifaces were used for.

6.1 Definition of Usewear

Usewear is a tool's observable physical degradation (Dowson 1979; Andrefsky 1998; Kooyman 2000; Odell 2003). The degradation itself is referred to as a *wear trace*, while usewear refers more to the study of such wear traces. Degradation is additionally the

failure of a tool from use, the product of two materials that interacted with one another. One of these materials can be ephemeral, such as wind or water interaction, or can be tangible such as wood, hide, or bone. Wear occurs on any portion of a tool that contacted another substance /material.

All objects fail, but failure does not necessarily imply catastrophic failure where the object can no longer be used. Nor does failure imply that a tool ceases to function, but rather the ability to function becomes increasingly hindered. Instead, most failures are but small chips on a tool's edge (Odell and Odell-Vereecken 1980). Such chips are referred to as microchips. Other types of failures consist of polishes, rounding, and striations. All of these failures can be either a loss or an addition to a tool's surface. Losses and additions represent particular agents, and the identification of these representations is sometimes a source of contestation among researchers (eg. Keeley 1980; Vaughan 1985; Grace 1989; Shea 1992; Smit et al. 1999).

The study of wear traces indicates aspects of an artifact's use-life. For demographers, use-life denotes the mortality of artifacts and in engineering it denotes the failure of artifacts (Shott 2002:94). Here the definition is broader and considers the entire history of an artifact from the collection of the raw material to its final excavation. As the tool is used not only is the worked material altered but the tool itself is altered. The result of a usewear analysis is that this use-alteration can be used as a diagnostic of how the tool was employed and upon what material it used. These failures are often microscopic and are grouped into four major types.

How usewear is created can be described as a layering process. The first layer, or scenario is the meeting of two opposing forces. These forces are the materials that make contact. The materials can be anything and the contact of these materials leave traces of this interaction (Keeley 1980). Materials move and hence connect through the energy expended by the person who used the tool (Dowson 1979). This energy or movement is often transferred to only one of the materials as the other remains static but has energy transferred to it from the opposing material. For the purposes here, one of these contact materials is always that of a stone tool.

The second layer to usewear is the consideration that one of the contacting materials may have multiple components. An example of this would be an animal hide or

carcass (Hayden 1979; Keeley 1980; Jacobson and Hogmark 2009). Such materials as this are composed of hair, flesh, muscle, bone, and so forth. It is unlikely that a tool would contact only one component of a hide or carcass, and so multiple materials can interact at once. This is important, for each component can leave its own diagnostic mark on the contact material. This produces overlap and masking affects on the stone tool's usewear.

A third layer is when foreign elements enter the contact zone. This foreign material is often sand or airborne grit that attaches itself to the tool or worked material (Keeley 1980; Vaughan 1985). These foreign particles remain loose but dig into the surface of both materials to produce striations. The size and shape of such particles create striations of different shapes and sizes.

The natural environment is the final layer. This can take two main forms, although there can be more. The first form is interaction between a tool and gasses or liquids, such as air or wind action (Anderson and Whitlow 1983; Wilson et al. 2006). This interaction can produce chemical reactions on the tool surface or act as a subtractive wearing process that smooth the tool's surface. The second form is interaction of solids, as in the case of a buried artifact. Soil naturally moves and therefore its particles can abrade the tool creating striations, chips, and polishes. Compounds in the soil can further create chemical reactions depending on Ph levels (Kay 1997; Wilson et al. 2006). Changing seasons can in addition affect buried artifacts. Transition of winter to spring creates freeze-thaw cycles that effect water trapped inside stones (Kay 1997). Water expands as it freezes and this can result in stone chips and breaks, sometimes mimicking other sources of microchipping.

6.2 Analogy in Usewear Studies

In many respects analogies are the basis of usewear inferences, just as much so for any other realm of archaeology; as Chang (1967:229) wrote, "no archaeologist is worth his salt...unless he makes an analogy or two in every monograph he writes". Data is gathered and compared between observed usewear on artifacts and from either ethnoarchaeological or experimental contexts (senso Odell 1988:36; Shelley 1999). Early instances of linking these bodies of research led to limited inferences and

experimentation that centered on a tool's margins and common tasks such as cutting or scraping (Odell 1988:36). Experimentation was critical as this trained the researcher's eye to identify use on artifacts, again illustrating the role of analogy (Odell and Vereecken 1980:90).

Bringing this data into the realm of interpreting tool use and how it fits into past human behavior is a process involved in Middle Range theory as espoused by Binford (Trigger 2007:294-303; David and Kramer 2001:18). Analogies are involved in both these steps. Observation is an initial step and analogies are involved through separating types of usewear. Analogies are critical to usewear projects but also teem with potential problems. The key to reducing the problems is to ensure that proper analogies are used, as explained at length by Alison Wylie (1985). Proper, or good analogies are created through forming numerous connections that tie one idea to another. Such connections are made through repeated testing and additionally varying the tests to examine if usewear is affected by alterations in variables such as increases in the pressure that is exerted on a tool.

Analogy is used in three steps of usewear analyses. First is the identification of wear traces. For instance, microchips are distinguished from polishes and differences are noted between microchips, such as feather, hinge, and step terminated microchips (Appendix A provides a larger discussion on microchips). A usewear researcher gains experience identifying wear traces through studying previous research and performing experiments that are used to differentiate wear types; in a way this becomes a form of classification. This is a usage of analogy for artifact wear is identified with this experience. In this fundamental way, usewear is not possible without analogy of linking the literature and experiments with what is observed on an artifact collection. It becomes critical that these analogies are correct because they are utilized at a fundamental level of the research. Odell and Odell-Vereecken (1980) indirectly discussed this when they advocated the usage of blind-tests to ensure that researchers properly recognized different forms of wear traces. For this thesis the analogy was grounded in limited tests with quartzite, chert, and obsidian, and through researching the literature.

A second application of analogy is to infer actions or function from the identified wear traces. This again is a fundamental of usewear research. A tool can be

experimentally used and the developed wear traces are then linked to that known task. This knowledge is then linked with similar wear traces found on an artifact. Another method is to analyze a tool used in a traditional setting during an ethnoarchaeological project. Hayden strongly defended the usage of ethnoarchaeology in usewear studies when he wrote that:

“the study of ethnographic implements has the advantage that the tools were used under traditional circumstances, with traditional resharpening regimes, and with traditional kinesthetic motor patterns. Thus, there is no doubt that the use wear patterns reflect accurately the conditions under which such tools were actually used –even if these cannot always be specified from the ethnography” (1979:207).

This is an analogical linking of wear traces from a tool with a known function and that of an artifact with an unknown function. This overlaps with the first usage of analogy but it is beneficial to consider these separately as it adds greater clarity to this discussion.

Analogy is additionally required when bridging an artifact’s inferred actions to larger tasks and group dynamics. This is the third role of analogy and represents the finality to a usewear project that receives little attention in the literature. Again, analogy operates under these situations by linking what was viewed on the artifact with ethnoarchaeological and /or ethnohistorical accounts, and with experimental archaeological scenarios. The ethnoarchaeological studies suggest aspects of human behavior that are involved in a task such as how wood is worked in relation to the division of labour in a society or how the skills of wood working are taught in that society. Ethnohistorical documents that were taken from the area in which the artifacts were discovered can propose the cultural backdrop to such tasks and perhaps confirm similarities between the ethnoarchaeological and ethnohistorical settings. Ideas can be indicated from this line of research such as what forms of cultural materials were made from a particular material and what oral stories are related to beliefs about that material and their products. These inferences produce a rich picture of the past that involve a usewear analysis.

6.3 Methodologies

Usewear studies commonly begin with a macroscopic approach followed by low and high-power approaches (Grace 1996; Odell 2003:139). This project was no different and

it, too, began with a macroscopic study using a hand lens (10x magnification) and the unaided eye. A hand lens is appropriate for discerning the presence and location of wear, along with characterizing flake scar morphologies. Macroscopic examinations focus on tool edges and have restrictive conclusions. These examinations were recorded qualitatively. Studies conducted on the reliability of macroscopic approaches have indicated poor results but are successful in noting the presence, location, and vague types of wear (Broadbent and Knutsson 1975:114; Young and Bamforth 1990).

Three different microscopes were used in the analysis of experimental flakes and artifacts. A dissecting microscope was the most often used of the three. This was a WILD M3Z Heerbrugg incidental platform light microscope with magnifications of 2.5x to 40x. The light source was a two-armed fluorescent secondary light source. This microscope was inexpensive and allowed for rapid analysis of artifacts; an average artifact took 20 minutes to analyze including written observations and microphotographs. The presence, location, intensity, and limited characterizations of wear such as rounding, chipping, striations, and polish can be made with the use of such a microscope. Nonetheless, intentional and accidental forms of polish cannot always be distinguished nor can it be given a detailed description (Keeley 1980).

A compound microscope was also used but to a lesser extent. Like the dissecting microscope, this piece of equipment was easy and relatively quick to use. The difference though, is that this microscope was devoted solely to the analysis of acetate peels that consumed a fair amount of time to construct (as discussed below).

A binocular lens Nikon Optishot (25, 50, 100, and 400x magnification) was the final piece of equipment used. This provided a high-power approach as it offered magnification of above 40x (Odell 2003:148). This microscope is similar to metallurgical microscopes in that incident lighting was directed from above, providing light for the sample at 90° and 45° angles. This is also known as dark-field illumination. Lighting and higher magnification enables a characterization of polishes and striae as the lenses differentiate changes in surface topography. Clearer images were available with this microscope that were automatically captured by a mounted digital camera and were then manipulated with Q-Capture Pro software.

Casts were made of some of the artifacts. Such casts were analyzed with the aid of the above-mentioned microscopes. There are three main reasons to make a cast of a stone tool. The first is that a cast is a flat negative relief of a surface (Knutsson and Hope 1984). Slanted surfaces are difficult to observe with microscopic lenses because they focus on only a small strip of a slanted surface. Flat casts provides larger areas to be viewed and therefore better microphotographs /recording of surfaces. Another advantage is that a cast can be taken over a tool's edge, flattening the angled edge. In addition, they provide a matte and uniform appearance in contrast to an artifact's original microtopography. For example, a microscope's light reflects off materials such as quartzite or patinated artifacts (Banks and Kay 2003). As the light shines back towards the observer, less detail of the microtopography can be observed.

Two types of casts were made during this project, but only one was successful. Acetate peels, or replicating tape, was the successful type and were analyzed with a compound microscope. This process begins with the cutting of small strips of replicating tape from a spool (part of this methodology comes from Knutsson and Hope 1984). The strip is cut slightly larger than the area that requires casting, as strips will sometimes partially rip. Further, a small amount of the strip needs to hang off the edge of the tool so that there is a portion to be grasped while removing the strip. Before and after the strip is placed on the tool, it is handled only while wearing clinical /plastic gloves and held only along the edges so as to not place any dirt or fingerprints upon the strip's surface. The artifact's surface is then cleaned, sometimes with acid. Once clean, a thin coat of 100% acetone is spread across the artifact's surface where the strip will be placed. This strip is then quickly placed atop the acetone. Sometimes this does not work as intended and the acetone is instead poured atop the strip. Either way the acetone is applied and the now partially melted strip takes the shape of the tool's surface. The strip rapidly hardens and after a few minutes it is carefully removed from the tool. A glass microscope slide with frosted ends is marked for what tool the cast came from and where it was taken. The strip is taped to this slide and stored for future analysis.

Acetate peels were taken of striated artifact distal edges. Unexpectedly, due to the grainy and pocketed surface of quartzite many of the acetate peels tore when removed from the artifacts' surfaces. Peels from obsidian or chert flakes were removed completely

and were quite clear, unlike the quartzite peels. The difference is likely due to the porous and grainy texture of quartzite. Due to this difficulty, a reduced number of peels were taken from the artifacts.

Dental molds are another type of cast. This is a technique borrowed from paleoanthropologists who originally borrowed it from dentistry (Banks and Kay 2003). At the time of these experiments a fellow graduate student, Cara Polio, was completing her thesis project using dental molds to produce reliefs of bone cut marks that were then studied with a scanning electron microscope (SEM). Since her casts worked out well, we both worked on casting the Eldon unifaces. The first step of the process was to apply Xantopren Comfort Light to a small area on the tool (Figure 6.1). This is a thick liquid material separated into two components inside a double tube. Upon release from the tube, the material mixes and hardens. Previous to the coating of the artifact, a small amount was mixed and spread on a table to ensure that the material properly mixed –a test dot. The mixture on the artifacts was allowed to dry for a few minutes as it hardened.

SEM samples need to be electrically conductive, which neither a stone artifact nor cast are. Metal, however, is conductive. A coat of metal (commonly Au-Pd) is thinly (3nm thickness) sprayed onto a cast, producing a positive relief of a tool's surface that does not obscure the sample's surface detail (Jose-Yacaman and Ascencio 2000:420). Without a metallic cast, electrons build-up on the surface while in a SEM's vacuum chamber (Jose-Yacaman and Ascencio 2000:420). This build-up results in *fuzzy* images that make it difficult to view diagnostic traces of usewear (Pollard and Heron 2008).

Dental molds had mixed results because some of the molds appeared under low-power magnification to have only made a copy of high-relief areas; the molds were quickly scanned under low-power magnification to ensure that a proper cast had been made. Numerous air bubbles were also found on the casts' surfaces. These bubbles were likely the product of the uneven topography that is present on quartzite. The bubbles could be easily mistaken for microchipping and would cast doubt on the reliability of noting other forms of wear. The dental mold casts were taken for future study with a SEM; however, the failure of the casts implies that a variable pressure SEM would instead be preferable since this type of microscope analyzes virtually any type of material

directly without the need of casting (eg. Pawlik 2000; Reichelt 2007; Pollard and Heron 2008). Due to financial and time constraints, no such device was used in this study.



Figure 6.1 Artifacts from FgQf-16 with drying dental cast material (blue). Mixing tube and applicator on the far right, along with 'test' dot.

6.4 Artifact Usewear Observations

Not all of the artifacts discussed in this thesis were microscopically studied. Artifacts from surface collections were not studied as much or intensively as those from excavated sites because the usewear was likely altered due to handling and chipping during cleaning or storage with other artifacts (see Appendix A for further information). Artifacts from HhOv-483 and 484, FgQf-16, Gowen, and Aitkow 3 (EgNp-63) collections were the most intensively studied for microscopic wear since their archival, cleaning, and excavation histories were better known. Yet, the EgNp-63 specimens were stacked on top of one another in a box, making non-intentional chipping likely. The Classic and Corner Eldon unifaces were also more intensively analyzed than the Amorphous or Side Eldon unifaces. This was because of time restrictions, sample size and that there were more Classic and Corner Eldon unifaces than the other two types. Further, the question of whether both edges of the Corner Eldon unifaces were used warranted investigation.

Some artifacts, in particular the EgNp-63 assemblage, have substantial amounts of calcification that is similar to concrete in texture and hardness. This occasionally obscured the wear from view, warranting its removal. Many authors advocate the usage of acids to remove such build-ups (eg. Binneman and Deacon 1986; Donahue and

Burroni 2000:143; Rots and Vermeersch 2000:157; Donahue et al. 2002; Banks and Kay 2003). Acid (HCL) and water were mixed to produce a 5-10% acid bath in which the artifacts were soaked for about ten minutes. The artifacts were then carefully cleaned of adhering particles with running water and left to dry; drying with paper or cloth towels leaves residue and there is a chance of accidental microchipping. Leaving artifacts in an acid solution for longer periods of time could remove artifact polishes. Kay (1997:651) suggested that particular acids like NaOH removes polishes more readily than KaOH, which removes only organic residues. Yet, Vaughan (1985:42) argued that the usage of HCL benefited the identification of polish and other forms of wear traces. Despite this difference of opinion, the amount of acid was increased over time for the Eldon uniface baths, as it had little to no affect on their calcium build-up. Even after leaving the artifacts in a bath for a number of days the acid solution still had no affect.

6.4.1 Alberta Boreal Forest: HhOv-483 & HhOv-484

There were few differences in the usewear between the HhOv-483 and HhOv-484 artifacts (Figures 6.2 and Figure 6.3). Because of this, the two tools were likely used for similar tasks. Due to limited access to a high-power microscope, the following two artifacts were not analyzed by such means and instead only a low-power method was used.

For the HhOv-483 artifact No.14, at 6.5x magnification the distal edge was visibly rounded and the proximal edge less so (Figure 6.2b and Figure 6.2e). The rounding also softened the distal edge. Projections along the left and right lateral sides had significantly more rounding with the original sharpness of projections removed (Figure 6.2c and Figure 6.2f). The right lateral edge also had a whitish appearance and may have been ground (Figure 6.2f).

The distal edge of No. 14 had been resharpened, but signs of usewear were still present on top of the resharpening flake scar lines. Microchipping was isolated along a small strip of the distal edge but it was difficult to characterize shapes or orientations. This wear flattened portions of the edge (Figure 6.2b).

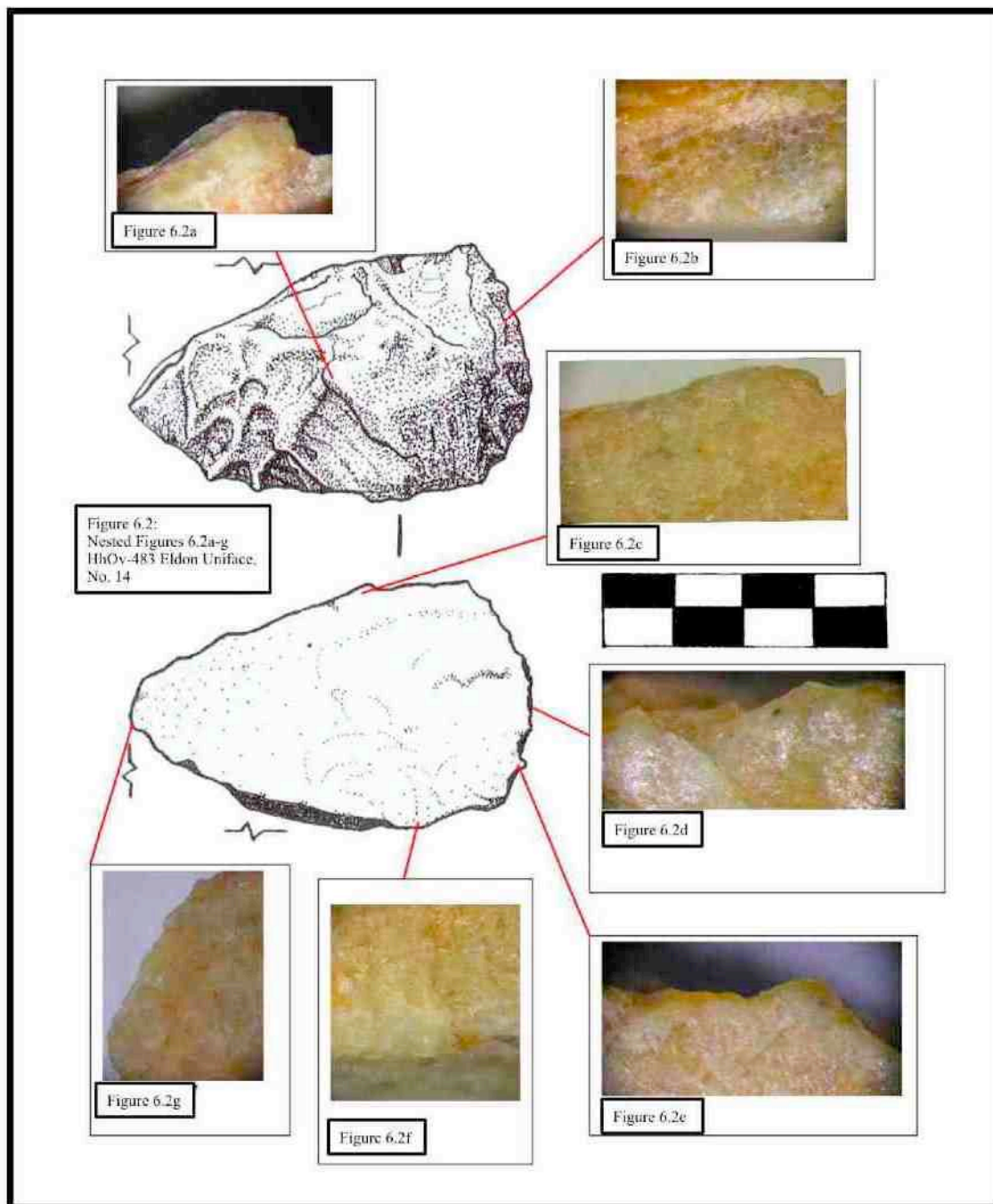


Figure 6.2 Usewear map of No. 14 from HhOv-483. Figures 6.2a-6.2g nested in Figure 6.2.

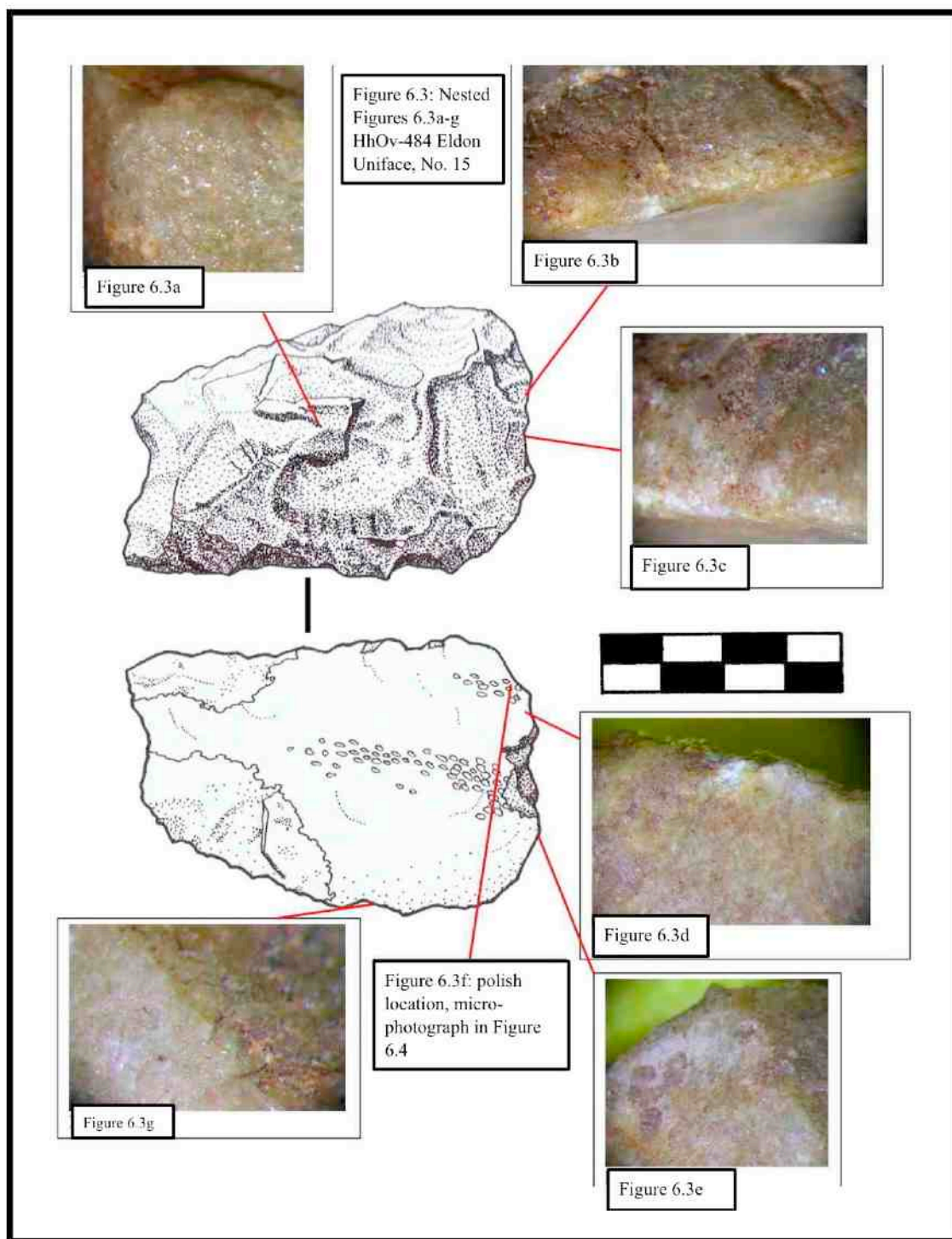


Figure 6.3 Usewear map of No. 15 from HhOv-484. Figures 6.3a-6.3g nested in Figure 6.2.

On the ventral face of No. 14, visible at 6.5x magnification, the center of the distal edge had a bright and highly reflective patch next to a crisply defined edge (Figure 6.2d and Figure 6.2e). At 16.5x magnification the rounded surface and projections were more readily identified but the polish was still nondescript and could be natural or the product of soil movement. More identifiable polish was noted on the proximal edge (Figure 6.2g). This polish had a flat but spotty appearance, which was likely the product of hafting. On the dorsal face, considerable wear was noted at 6.5x on the high-relief of a thick section (Figure 6.2a). This high spot had some whitening and the individual crystals were difficult to distinguish. This was also true for other high-relief points along the dorsal interior surface. This might be the product of abrasion from the haft.



Figure 6.4 Polish (40x) on proximal edge of No. 14.

Similar to No. 14, the edges along the ventral face of No. 15 from the HhOv-484 site were well worn. The edges were softened and rounded, being especially acute along the distal edge (Figures 6.3b and 6.3c). Numerous circular crushed areas were also found across the ventral face (Figures 6.3d and 6.3e). These spots were small, measuring less than a millimeter in diameter. Small impact scars were moreover found away from the

edge in the interior of the ventral face. These scars were reminiscent of hammer strikes on experimental cores (Figure 4.4 in Chapter 4, section 4.2.2).

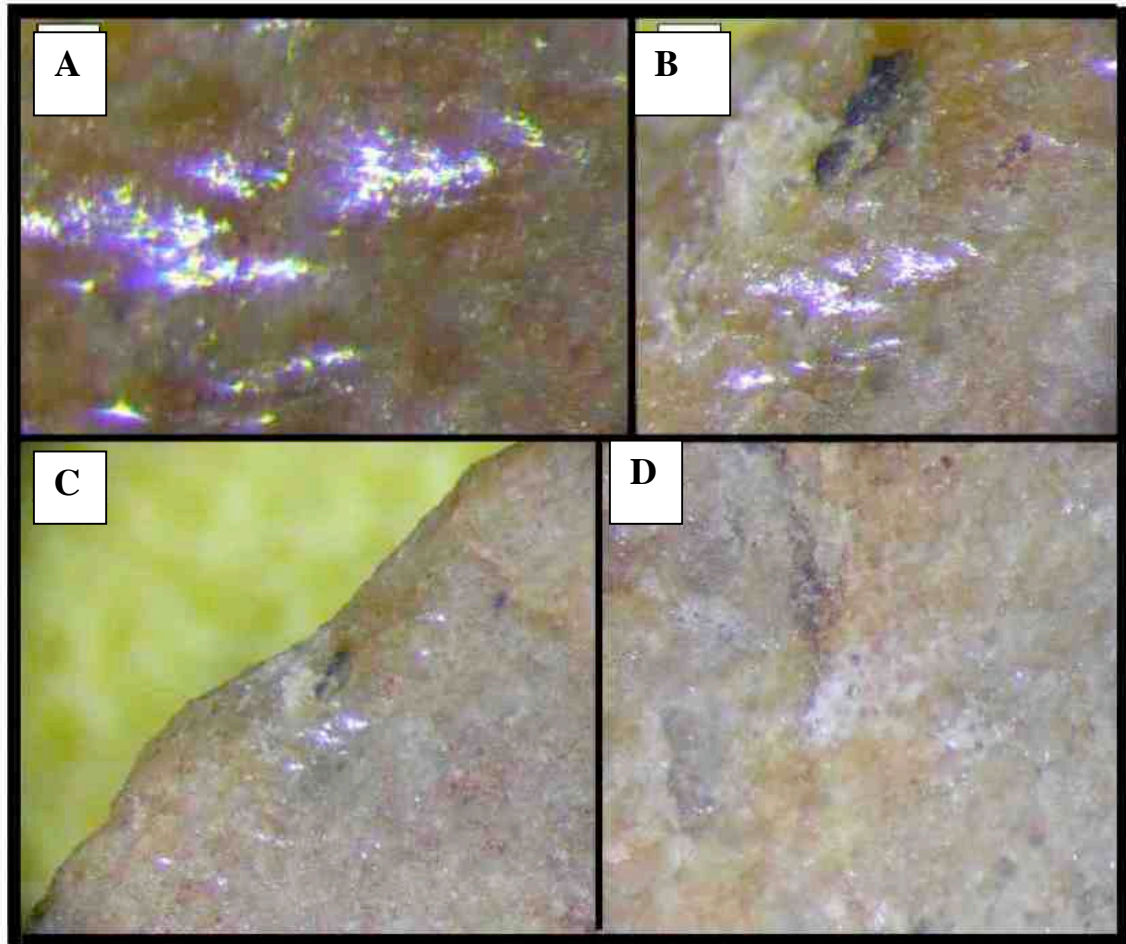


Figure 6.5 Polish from ventral face of No. 15. Images A to C at three different levels of magnification (40x, 25x and 6.5x). Image D from the same tool (16x) where there was no polish.

The distal edge of No. 15 was somewhat flattened, similar to No. 14 (Figure 6.3b and Figure 6.3c). The center of the distal edge on the ventral side had a large flake scar, but although present, no individual microchips could be characterized. The left edge of this scar was rounded, but this did not enter the scar itself indicating this chip removal occurred at the end of the tool's use (Figure 6.3e, the darker area on the right is the slope into the flake scar, and the lighter area on the left is rounding that does not enter the darker area of the flake scar). There were no signs of striations, but possible polish on the left distal corner of the ventral side was observed (Figure 6.3f and Figure 6.4). Again,

like No. 14, the highest central region on the dorsal surface was heavily rounded and softened (Figure 6.3a). Individual crystals were diffuse. Attempts had been made to remove these high and thicker portions of No. 15 as conveyed by the bashing that was found around the sides of these regions (recall the discussion of an attempt to thin these artifacts, as mentioned in Chapter 4).

Both No. 14 and 15 had high-relief as opposed to low-relief wear along the proximal half of the artifacts, implying that the tools were in contact with a hard material. A softer material would fold into the low-relief areas, likely related to friction between a handle made of a hard material and the tool's surface. Flattening to the distal edges of No. 14 and 15 was similar to what was observed on the experimental quartzite flakes used to scrape wood, which corroborates the usage of the HhOv artifacts to process medium to hard materials. Furthermore, there was pronounced rounding along the edges that further substantiates this argument. As for motion, the lack of striations and microchips makes it difficult to determine how the tool was used.

6.4.2 Western Alberta: FgQf-16

The high-power approach was used to analyze four of the FgQf-16 site artifacts (No. 65, 66, 73, and 76). The four were chosen for their relative completeness (many other artifacts were proximal or distal remnants) and for their potential usewear as identified during a previous low-power analysis. One of the more important observations was that polish was identified on the ventral faces. Much of this polish was observed on the proximal halves and was likely related to hafting.

The first artifact analyzed from FgQf-16 (No. 76) was medially snapped, leaving only the distal half. This artifact was studied with the unaided eye, magnifying glass, and the low and high-power approaches. Without the aid of magnification, spurs were observed on the center of the distal edge (Figure 6.6a). Weedman (2002) discussed such spurs in regards to Ethiopian hide scrapers. Spurs, according to her, would be removed through edge resharpening as they could easily tear a hide. The retention of spurs on this Eldon uniface suggests that the potential of hide tearing was not a priority, implying that these tools were used for non-hide working tasks.

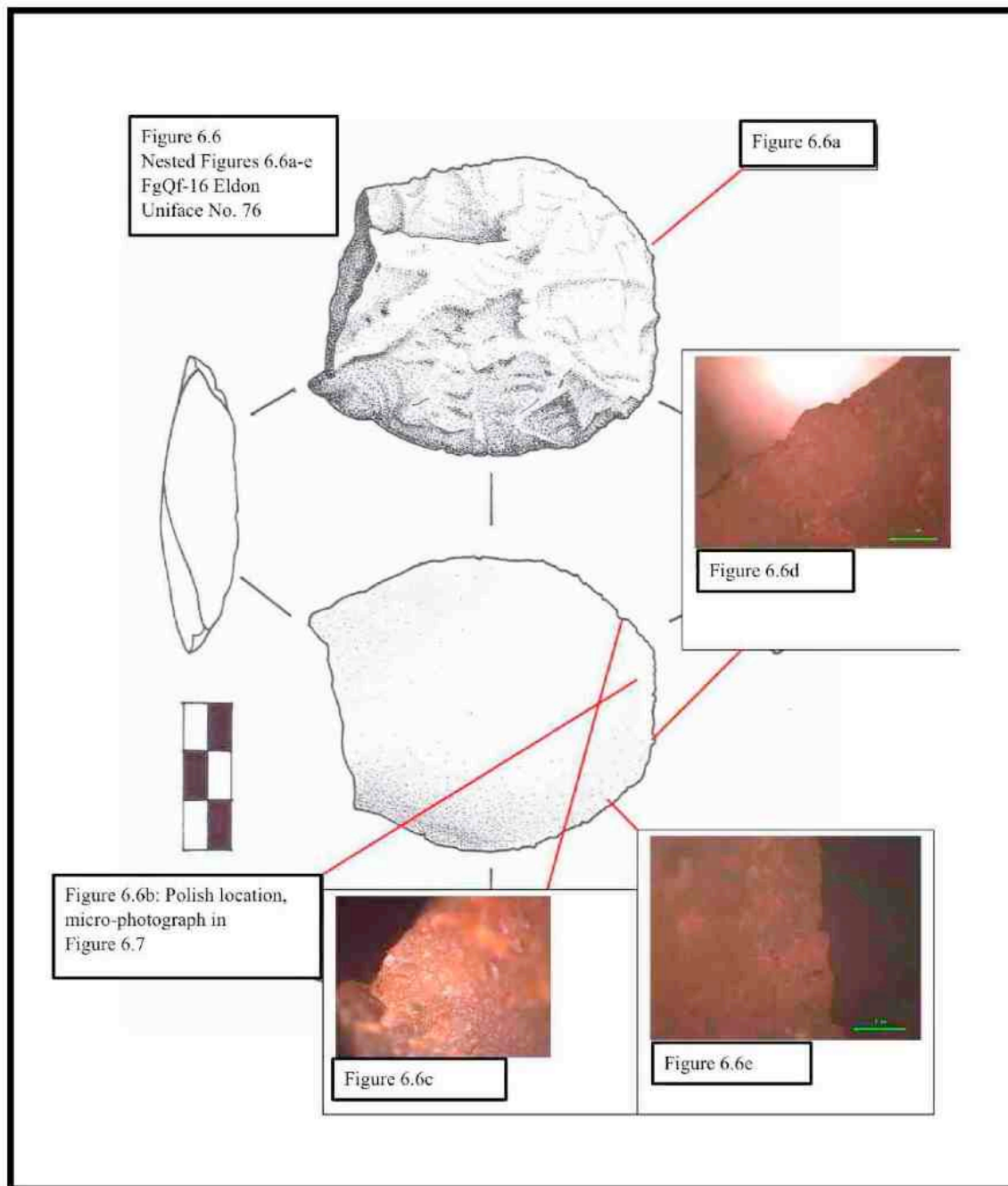


Figure 6.6 Usewear map of No. 76 from FgQf-16. Figures 6.6a-6.6e nested in Figure 6.6.

Visible without the aid of magnification was a small sharp projection located on the snapped surface of artifact No. 76 (Figure 4.16 from Chapter 4, section 4.2.4). This snap was likely intentional since the surface was smooth except for the small projection on the edge (Owen 1982:77). If No. 76 was used following the snap, such a projection would be dulled as this would have been cradled in the hand or haft. Therefore, the tool was likely abandoned following the medial snap.

The distal edge of No. 76 had microchips and a slight softening of the lateral edges. At a higher magnification of 40x, individual grains were observed that had been removed from the lateral edges much like occurred during the experiments (figure 6.6e). The high-relief on the dorsal face was softened, much like was previously mentioned for the HhOv artifacts. Returning to the distal edge, step terminated microchips were observed at 6.5x on the dorsal surface. As demonstrated Odell and Odell-Vereecken (1980), such chips are created by interaction with medium to hard materials. On the ventral face of this same edge were impact or crushed areas, again similar to the HhOv artifacts and indicating hammerstone strikes from resharpening episodes. Still on the ventral face of this edge was a small spot of polish (Figure 6.6b). This polish was not continuous and measured 6mm along the edge and ran 4mm away from the edge. The polish was again observed under higher magnifications of 100x to 400x (Figure 6.7). Located on high-relief ridges, this indicates that the processed material was of a medium to hard toughness as it was not soft enough to interact with the low-lying areas.

Eldon uniface No. 65 was one of the few unbroken artifacts from the FgQf-16 site. This artifact was unusually large, feasibly related to a difference in function. In support of this, at low-power magnification microchips were observed on the ventral face of the distal edge. These microchips were small, scalar shaped, and depicted in Figures 6.8a and 6.8b, where a red-dome-shape encompasses the scar. Such scalar chips are commonly formed when working soft to medium materials. However, step-terminated scars were also observed on the dorsal face under high-power magnification. Akin to the HhOv artifacts, the distal edge had been slightly flattened, rounded, and crushed (Figure 6.8c).

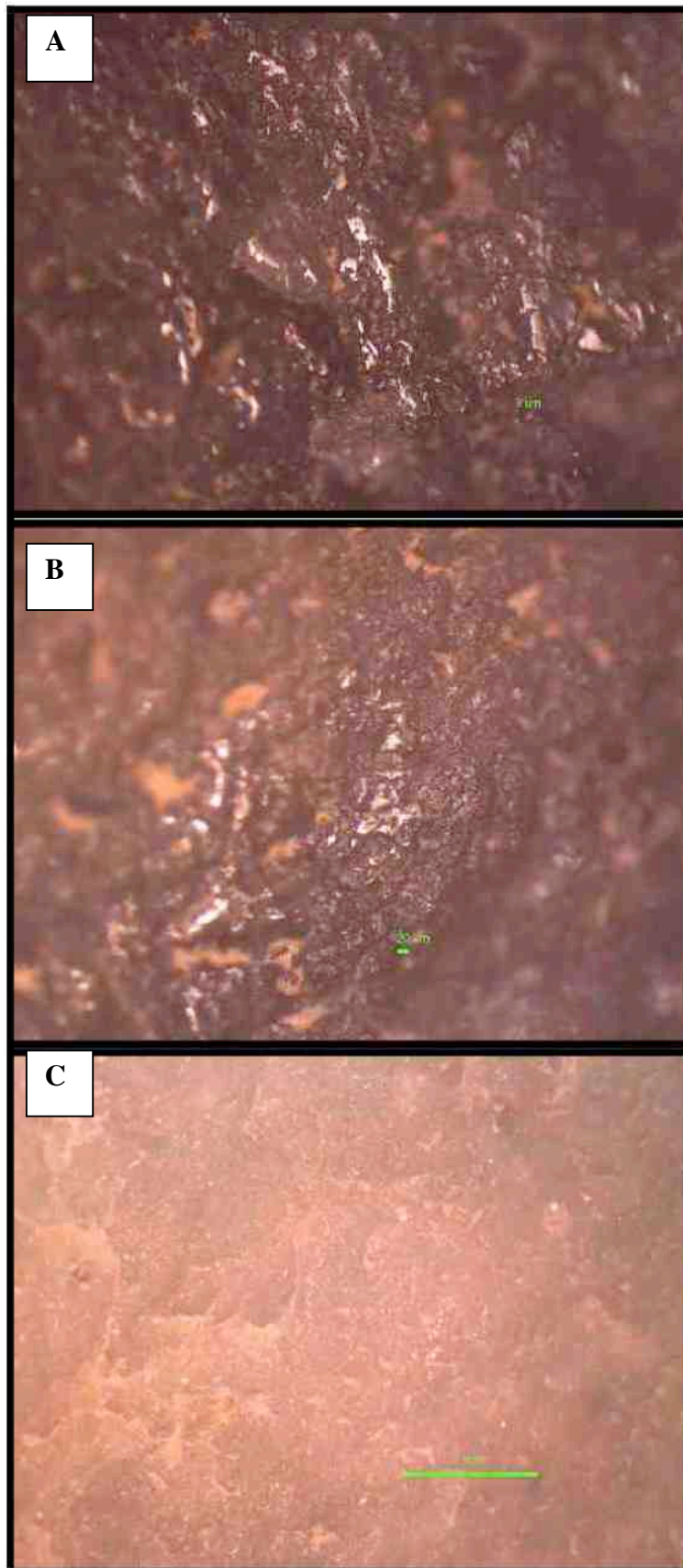


Figure 6.7 Polish seen at three different magnifications, top: 200x, middle 100x, and bottom 50x magnification. The polish is indicated in Figure 6.6b of FgQf-16, No. 76.

Polish was identified with high-power magnification on No. 65, spread across the proximal half of the ventral face (Figures 6.8d and 6.9). The ventral surface was slightly domed and the polish at the top of the dome continued towards the proximal edge. The polish was more prominent the closer it was to the proximal edge. Like No. 76, the polish entered the low-relief of the ventral surface. Multidirectional striations were additionally found in these polished areas of No. 65. The orientation and placement of the polish, along with an association of striations links this with hafting wear.

The dorsal surfaces of Nos. 73 and 71 were rounded and worn. There was also prominent rounding on high-relief (Figure 6.10a for No. 73). The arris of edge scars near the proximal half were particularly well rounded. Microchipping was found on the proximal edge of No. 71 but not 73. The left lateral edge was flattened and soft to the touch for No. 73, and similarly, No. 71 was softened and flattened at the tops of projections along the lateral edges; this rounding was more prominent on the spines closest to the distal edge. Specific to No. 73 were step terminations and shattering at distal lateral corners. The ventral surface had small bright polish patches (Figure 6.10b for No. 73), and again unique to No. 73 were bashed areas with reddening. For No. 71, edge rounding, flattening and step fractures were also noted on the ventral surface. Spines /projections were likewise crushed on the right lateral edge with associated microchips on the ventral surface (indicated within the dashed-red circle in Figure 6.11). In addition, feather-terminated microchips on the dorsal surface mirrored those from the ventral.

No. 66 and No. 73 were also studied under high-power magnification. The first, No. 66, had striae within very bright and small patches of polish along the distal half of the ventral face (Figures 6.12, 6.13 and 6.14). Forming a *u* shape near the distal edge on the same face was a small bright polish. The striae within this polish were vertical to the distal edge. High-relief on the dorsal face of the tool was likewise crushed and rounded. Similar features were observed on No. 73, including bright patches on the ventral face. Polish was a spotty and there was a bright patch in low-relief on the proximal edge. Microchips were also found on the proximal edge.

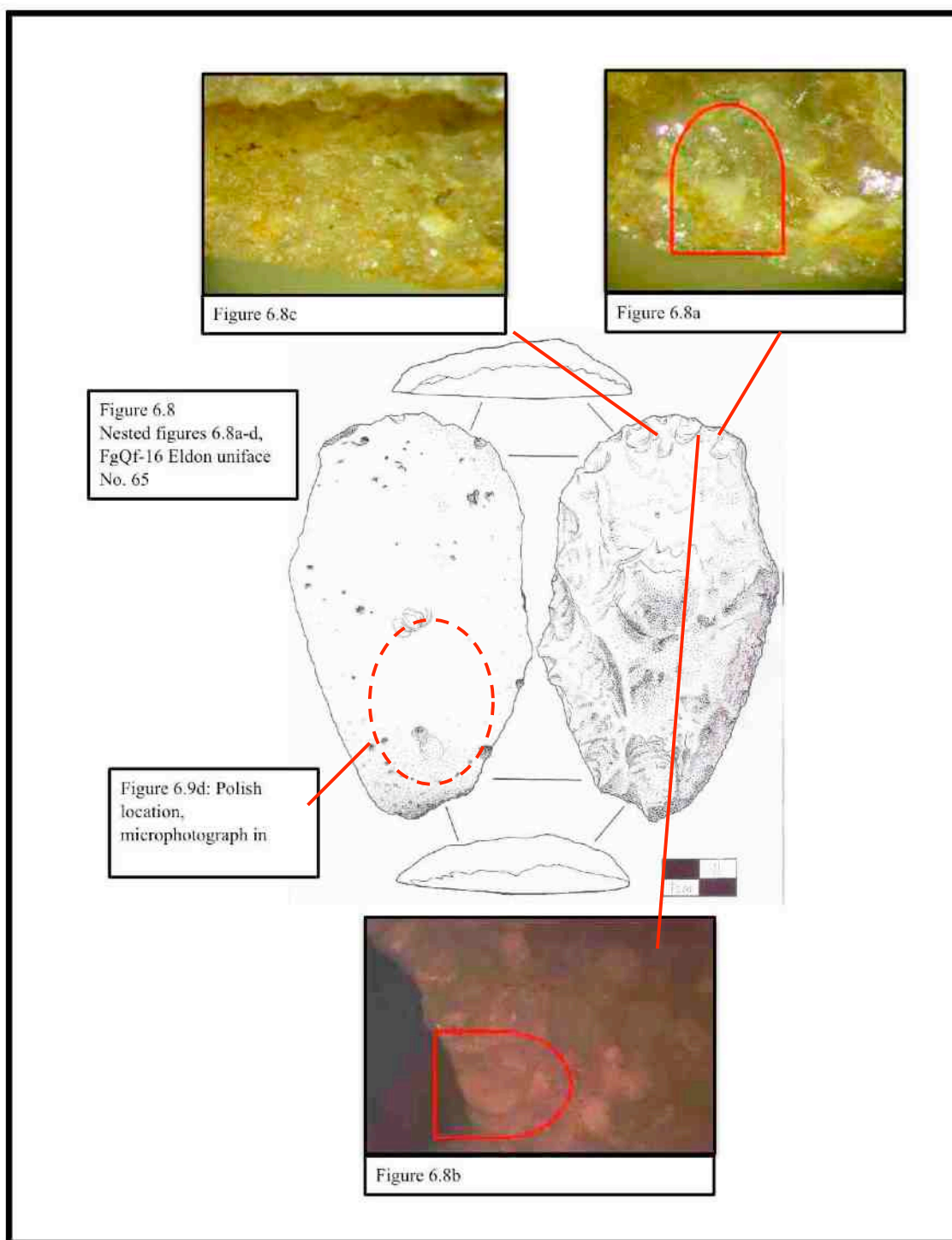


Figure 6.8 Usewear map of No. 65 from FgQf-16. Figures 6.8a-6.8d nested in Figure 6.6.

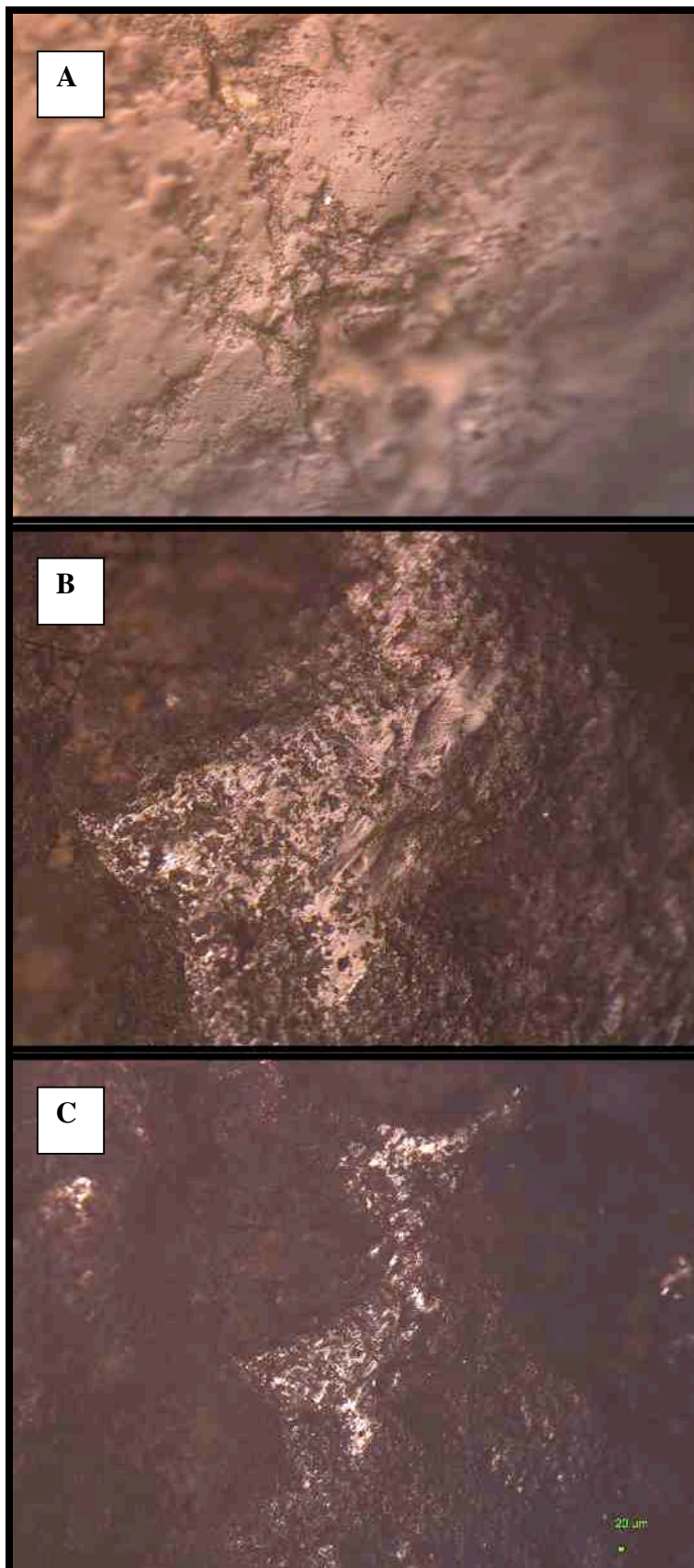


Figure 6.9 Three images of polish located in Figure 6.8 of Eldon uniface No.65. The C is at 50x, B at 100x, and A at 400x magnification.

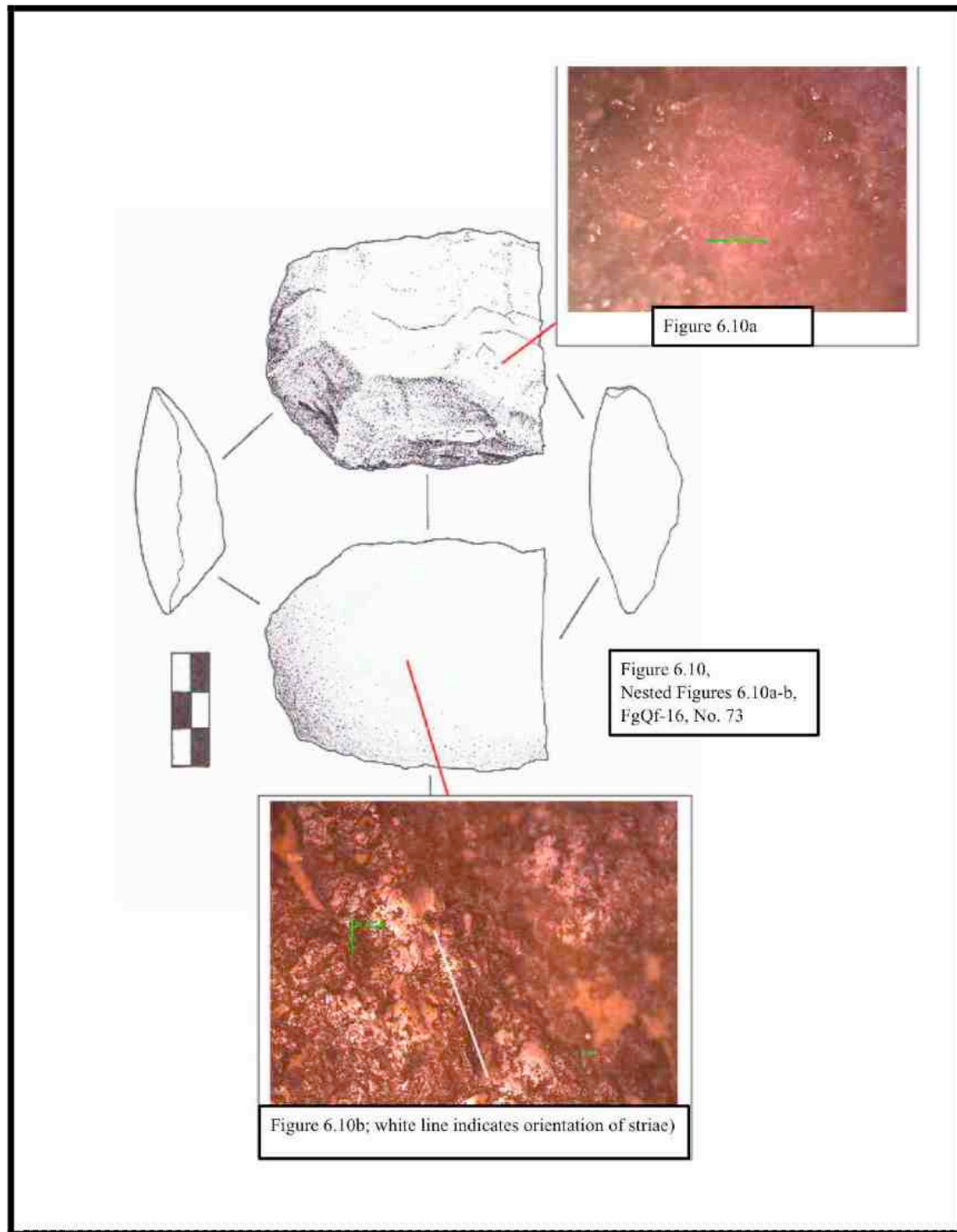


Figure 6.10 Usewear map of No. 73 from FgQf-16. Figures 6.10a-6.10b nested in Figure 6.6.

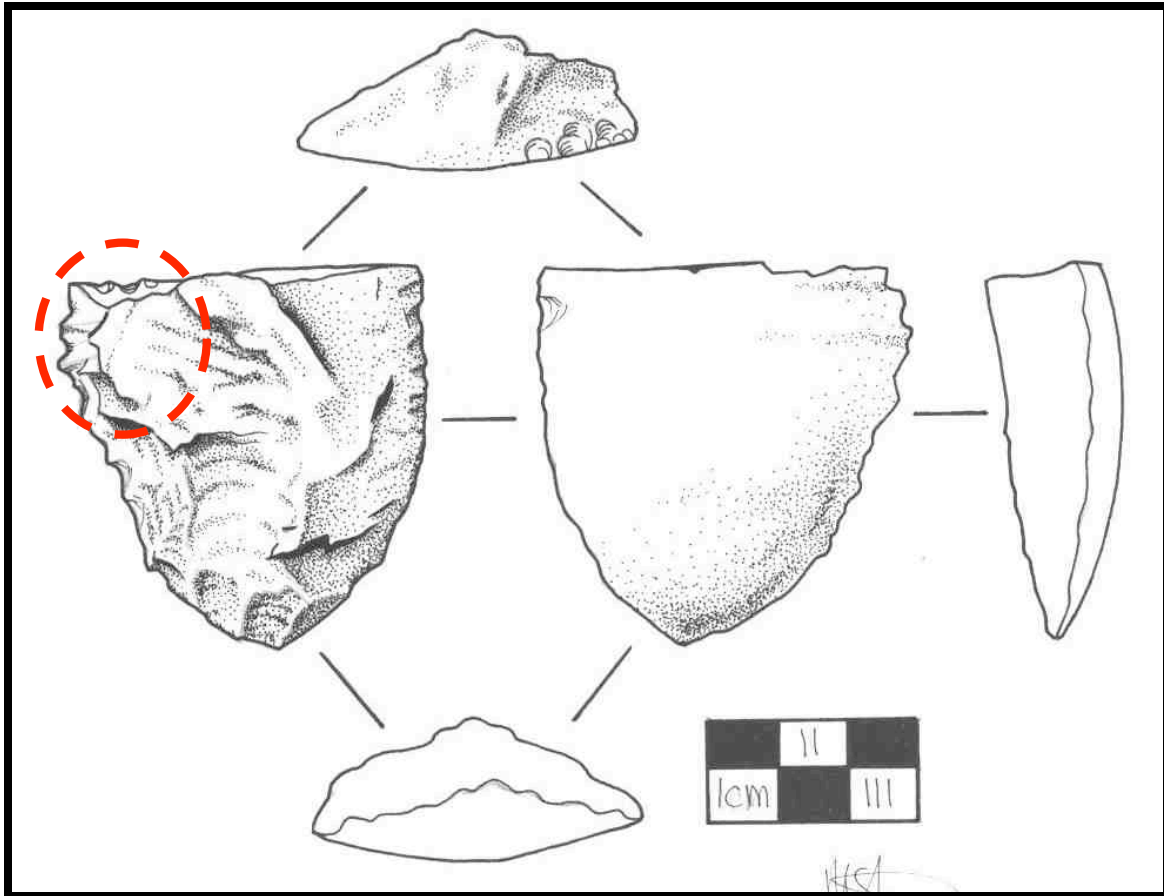


Figure 6.11 FgQf-16 No. 71 (spines /projections noted within red-dotted circle).

Polish was only noted for the ventral (cortex) faces of the artifacts because the surface topographies are different. This topographic difference affected the way polish formed. Quartzite is a very hard lithic material, and because of this, abrasion is slow to develop. The rough dorsal surface is slowly smoothed as it is worn, perhaps eventually appearing polished. However, this is not found on the artifacts here and only the initial phase of wear (a worn /ground surface) was evident. Such a process can likewise occur on the ventral surface, but as this is already smoother than the dorsal surface, the polish forms more quickly through a subtractive or additive process (see Appendix A). Accretions are not found on the artifact's dorsal surface, either. Cracks and striae in the polish support the role of accreted polish (No. 66 is depicted in Figure 6.12, and the polishes are shown in Figures 6.13 and 6.14). Cracks indicate the presence of an additive polish because they show a breakage not in the tool's surface but in something that lies

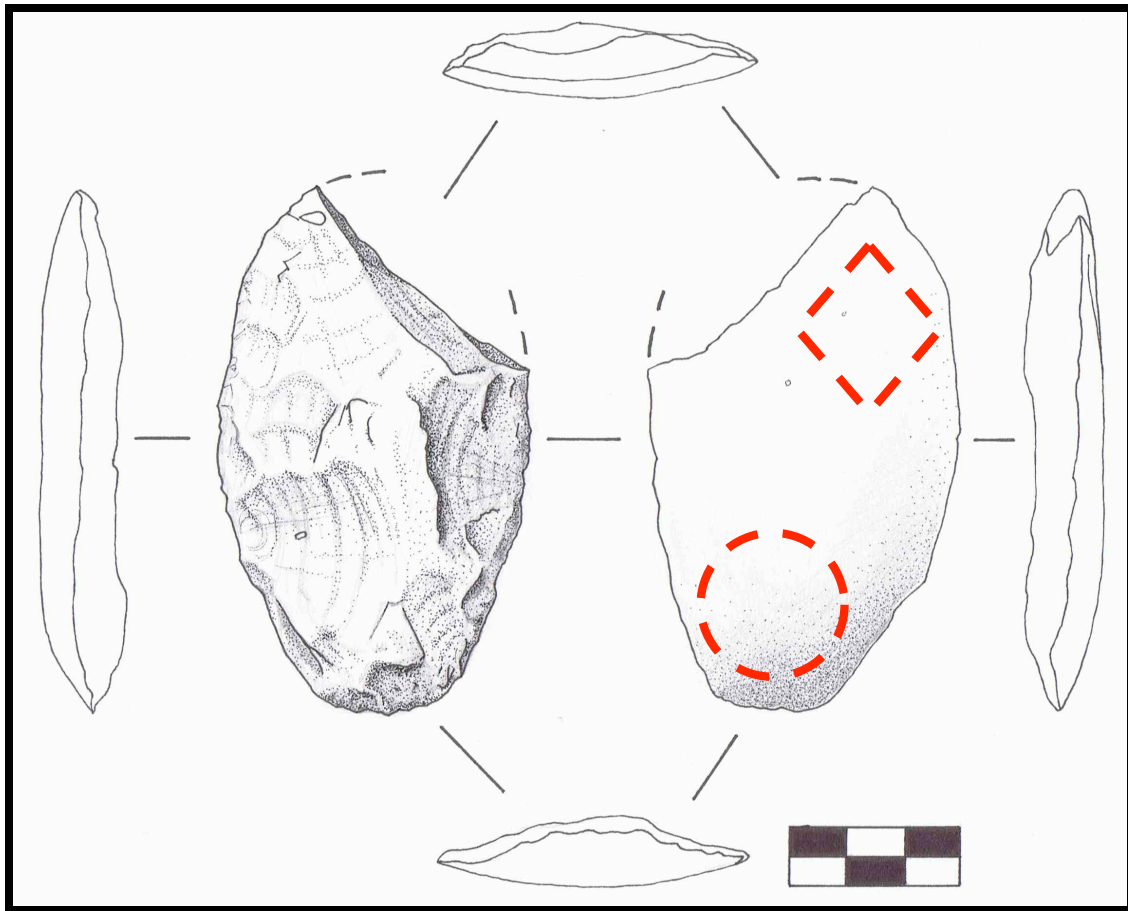


Figure 6.12 FgQf-16, No. 66 (red dotted circle indicates area of polish shown in Figure 6.13, and the red dotted diamond indicates area of polish shown in Figure 6.14).

atop. Similarly, the observed polishes were not always complete, and open spaces of the unaltered artifact surface were present. Following the solidifying of the polish, age or changes in the microenvironment that the tool was situated within may have caused these cracks. Age and microenvironment refer to the continual freezing and thawing of the stone tool over the years, which may have resulted in the stone artifact subtly bending and constricting with the seasons. This distortion would be unnoticeable when viewing the natural surface of the artifact, but an additive material like the polish is a weaker material and hence would form small microscopic fissures with a yearly distortion. In relation to this, the microenvironment is the small area in which the artifact was buried that can periodically dryout. Water can be expelled from the polish since it has a higher

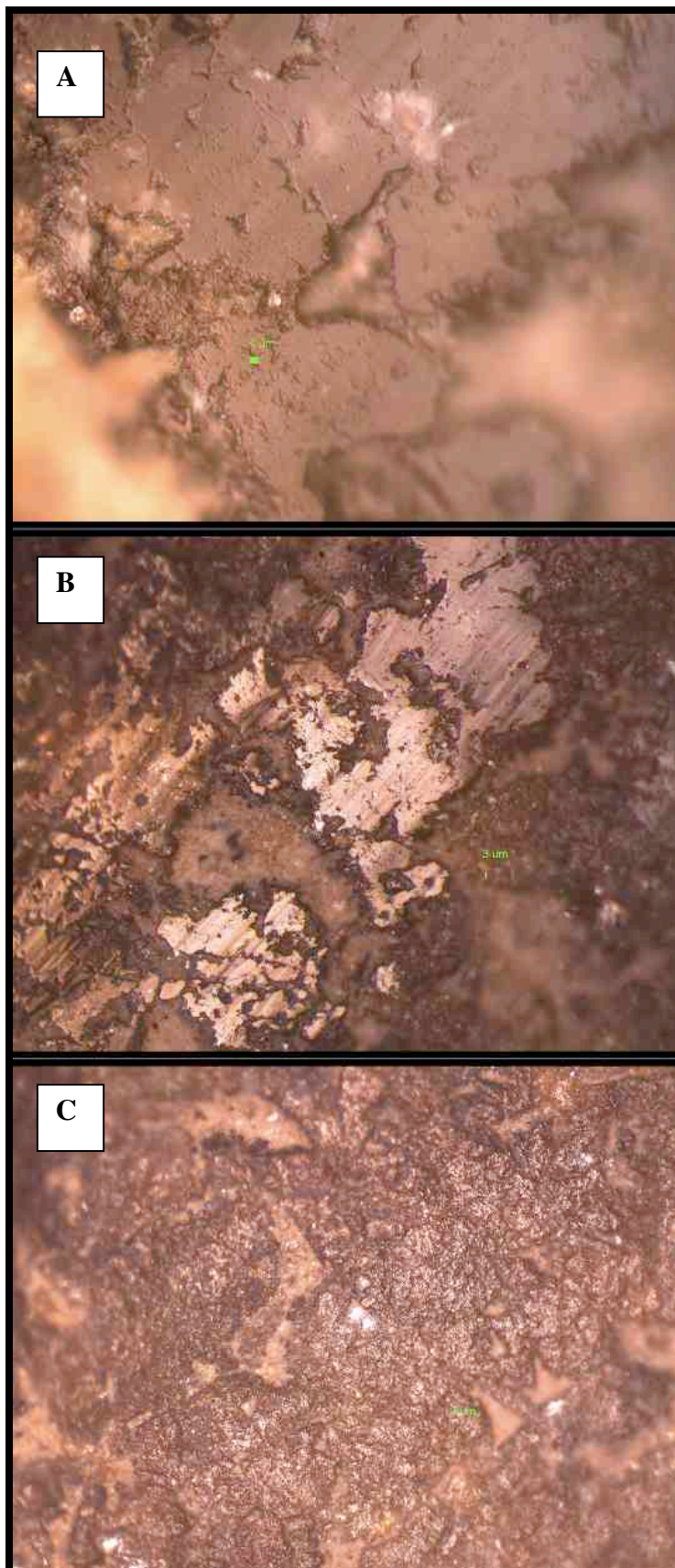


Figure 6.13 Three images of polish in the proximal region of the ventral face on No. 66, FgQf-16 of Figure 6.12. Polish shown in C at 50x, B at 100x, and A at 400x magnification.

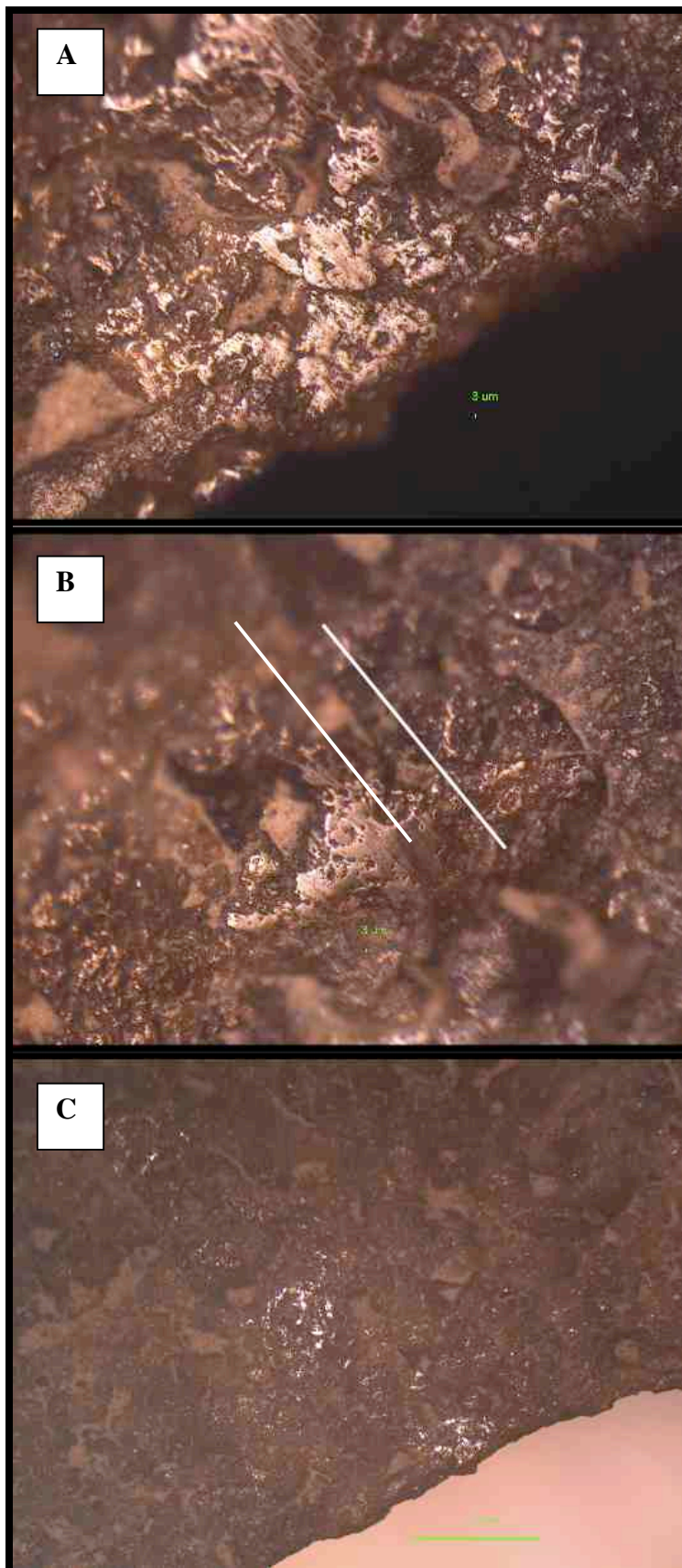


Figure 6.14 Three images of polish along the distal edge of No. 66 ventral face in Figure 6.12. Polish shown in C at 50x, B at 100x, and C at 400x magnifications.

water content than the stone (see Appendix A in regards to descriptions of polishes composed of silica). This loss of water would dry, crack, and perhaps shrink it.

A second reason that polish is considered additive is because striae are present in the polishes as a result of the tool gouging into the softer surface. These striae begin and end in the polished surfaces. If the area was not a polish, or the polish was a 'subtracted' area, then the striae should have continued. In addition, these striae did not have well defined borders, suggesting that they formed in a soft or liquid substance that later became a hardened polish (Vaughan 1985). Accreted polishes such as this can develop from processing hides and soft woods.

6.4.3 West-Central Saskatchewan: Gowen Sites

Unlike the previous sections that discussed the artifacts individually, the following paragraphs present information on a group of 3 artifacts (No. 118, 148, and 150) from the Gowen site that all have similar usewear: flattened and striated distal edges. This is unlike the previous Alberta sites, where the artifacts had similar wear traces but also enough differences to warrant discussing them individually.

Striations and flattened distal edges were observed on many of the Gowen site artifacts. These phenomena were found on both Classic and Corner style Eldon unifaces, such as No. 148 that was a Classic type (Figure 6.15). These striae were located on the distal edges where the bottom half of the edge was flattened and slightly angled. Figure 6.16 depicts the flattened distal edge on No. 148 without the aid of magnification.

In Figure 6.17 there are two images, with the top taken at 16x magnification and the bottom at 5x magnification. In the top image of Figure 6.17, red lines are positioned next to the striations to indicate their direction. In the bottom image, (A) two flake scars on the dorsal surface are bisected by the flattened edge, and below that (B) the ventral surface abruptly adjoins the flattened edge; both aspects of this bottom image (A and B) are labeled and have red lines outlining their shape. This flattened edge is similar but larger to those previously discussed. Even though it is larger, it does not extend across the entire length of the distal edge. As mentioned earlier in Chapter 5, pliable materials can flatten the entire edge, indicating that a hard material like wood produced the flattened edge on No. 148. Additionally, striations on No. 148 are large and have *u*-shaped troughs.

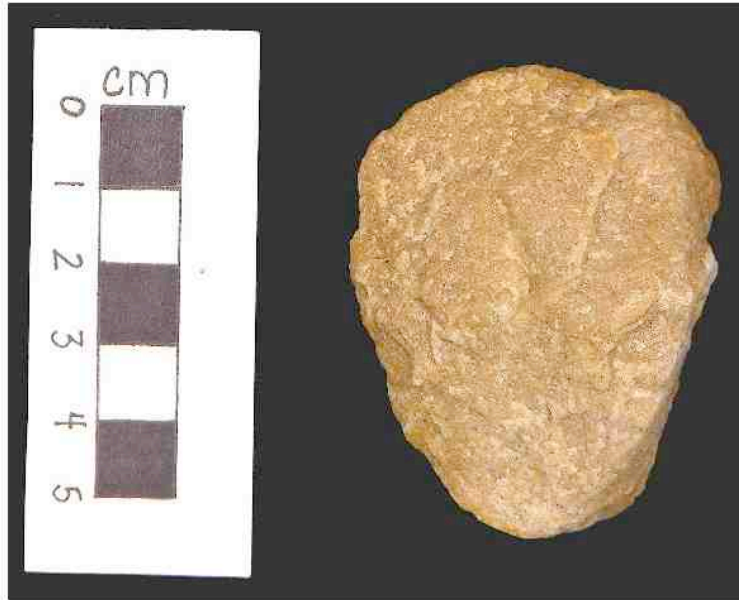


Figure 6.15 Dorsal surface of a Classic Eldon uniface from the Gowen site, No. 148.



Figure 6.16 Ventral surface of Classic Eldon uniface from the Gowen site, No. 148. Flattening appears as the darkened strip along the left and right part of the distal edge.

They are found only on the flattened portion of the edge and are orientated vertically to the edge (top image of Figure 6.17).

Many of the Eldon unifaces from the Gowen sites had flattened distal edges like that of No. 148. Since the areas of interest are on a slant, it is difficult for a microscope lens to focus on them. Elevating the artifact so the slanted area is level to the microscope lens does not help. This simply lifts the artifact too high for the lens to move into focus since the artifact was placed on a stationary stage that could not be moved downward to

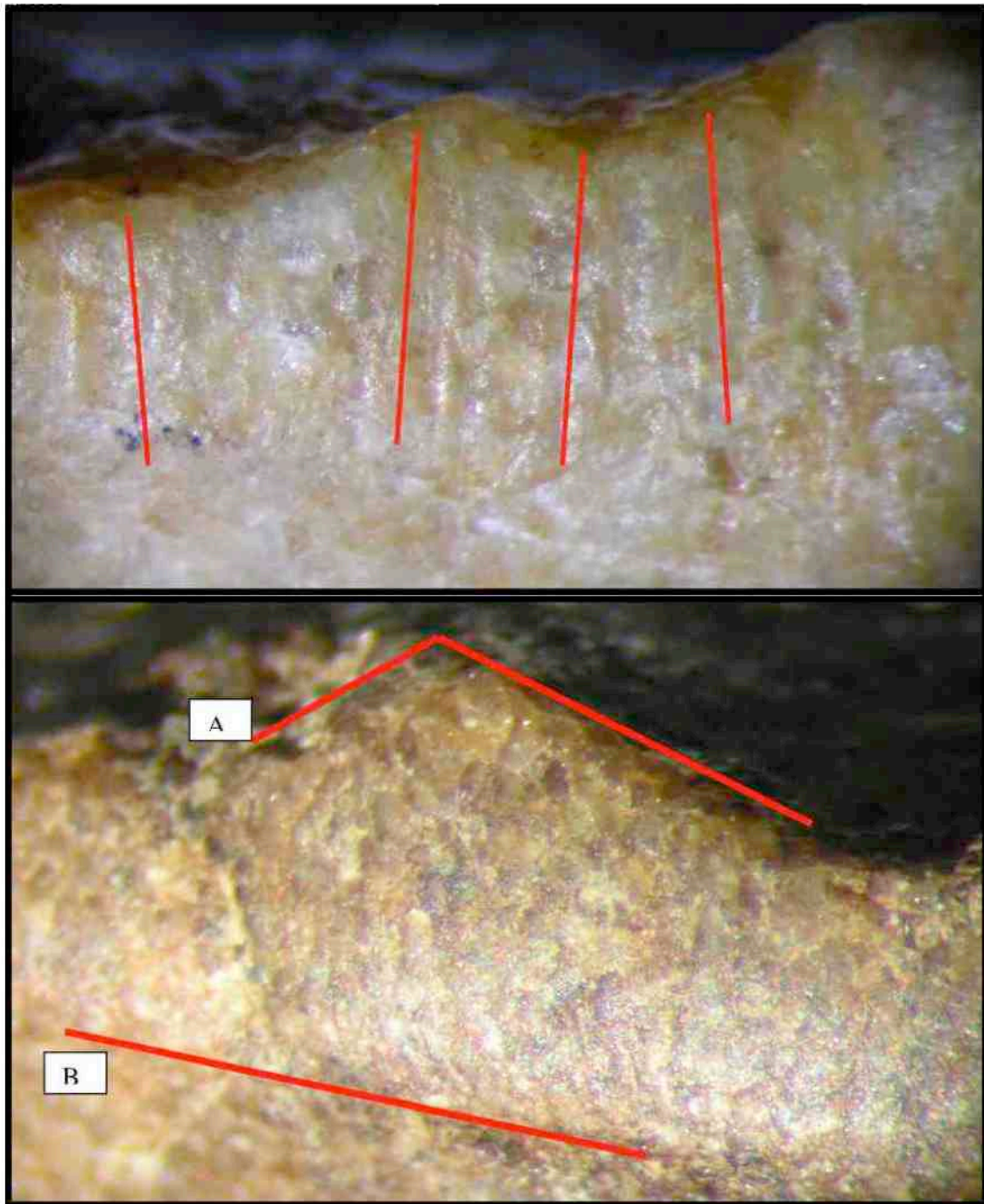


Figure 6.17. Striations on the flattened distal edge of Eldon uniface No. 148 from the Gowen site.

compensate for the artifact's elevation.

Acetate peels proved effective in studying the flattened distal regions because they produce a flat negative surface of an artifact. These peels established that the striae had smooth edges and *u*-shape troughs (mentioned above with No. 148). Such a peel was taken from No. 150 (Figure 6.18); red circle at the bottom encloses an air bubble that had



Figure 6.18 Acetate peel of the flattened and striated distal edge of Eldon uniface No. 150 from the Gowen site (40x magnification).

formed on the peel. These striations are parallel to one another and evenly spaced apart. This is very similar to striations found on No. 118 and shown in Figure 6.19. Here, white lines are located next to striations to help indicate their orientation. Red u-shaped lines are to the right of the white lines. The curvature of the striations is suggested by these red lines. If the striations were instead V shaped, then one side of the striation would be shadowed due to the angle of the trough, but instead the shadow within the striation is more gradual, indicating it is u-shaped.

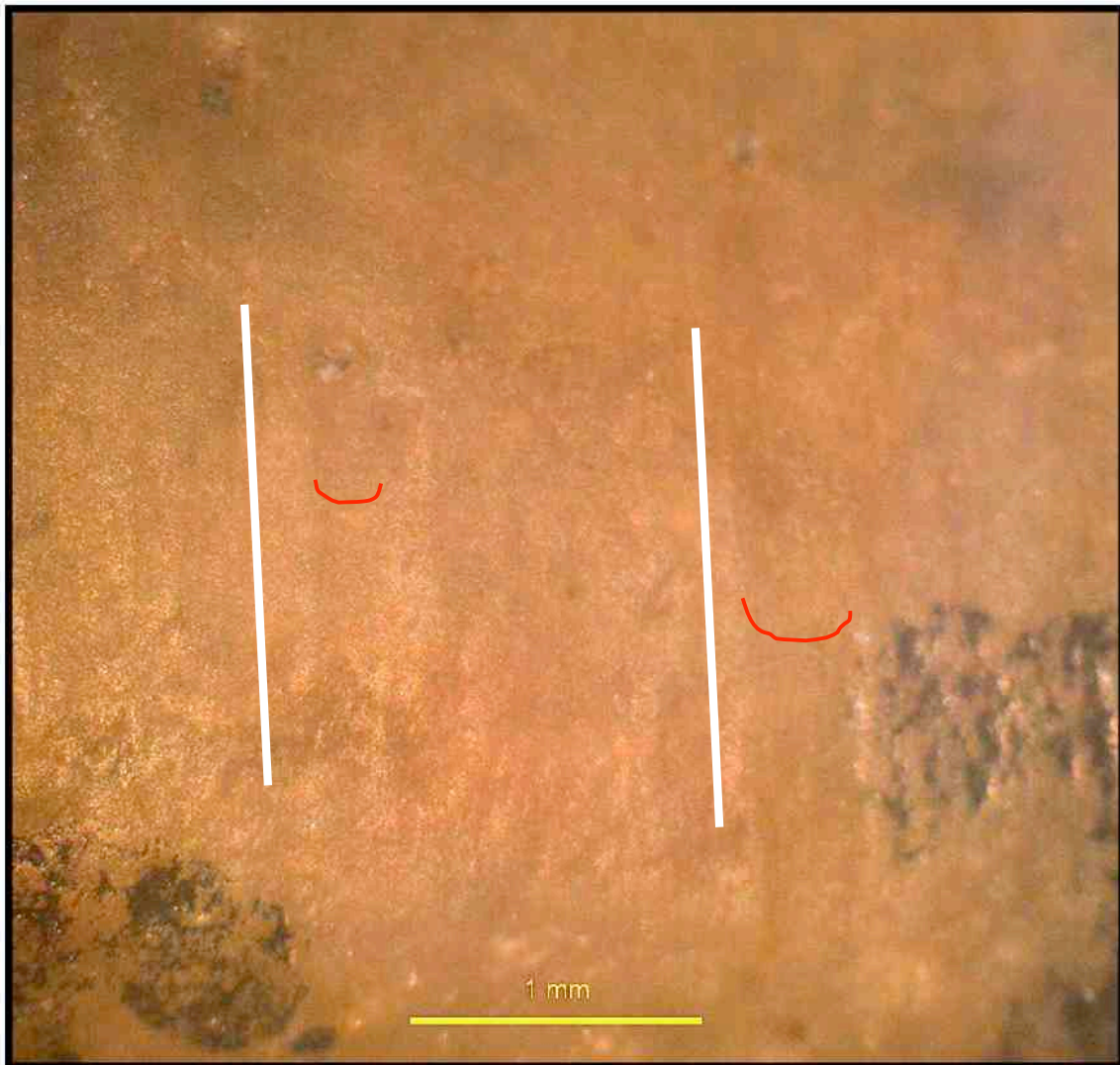


Figure 6.19 Striations on Eldon uniface No. 118 from the Gowen site (100x magnification).

The u-shaped striations are not consistent with those produced by small and angular sand or grit particles when working hides in gritty environments (Vaughan 1985) and instead likely occurred during contact with raised areas on a medium to medium-hard material like wood, bone, or less likely, antler (Walker and Long 1977; Sands 1997). The shapes of striations are a direct reflection of what produced them, so sand and grit produce angular, v-shaped striations and not u-shaped striations as those found on the Gowen artifacts. Sand and grit also move around as they are not stationary and hence produce overlapping, numerous, and non-parallel striae. Again, this is not observed on the artifacts discussed here.

The Gowen striations were produced from what I would refer to as *rail* phenomena. This is where a projection digs into the tool as it works that material. The projection is stationary and hard enough to gouge the tool. Wood grains are an example of stationary projections or *rails*. These grains do not move, can be homogenous in size and spacing, and as the wood is slowly removed the grains continue through the wood and do not automatically disappear with the removal of the wood.

Under higher magnifications of 100 to 400x, these striations appear deepest at the tip of the distal edge and are shallower further away from the edge. Unfortunately, due to the angle and greater magnification, microphotographs could not be taken. Nonetheless, a striation is formed when pressure is exerted on a tool while working a material. The area of a tool where more pressure is applied is also where striations will be deepest. Striations will become gradually shallower the farther they are located from the source of pressure. As the Gowen Eldon uniface striations are deepest at the distal tip, it implies that pressure was exerted at the tip of the tool.

Striations signify an artifact's movement. As shown by Vaughan's (1985) experiments, striations that form only on a tool's leading edge are created by transverse actions. When these striae appear only on the ventral surface, such as the Gowen artifacts, then this occurred because the tool had a "high or obtuse edge angle [and] was held at a high angle of contact" (Vaughan 1985:25). In cases such as this, the non-contact surface would be the dorsal face /edge. This is also corroborated in the Gowen artifacts for few of these have microchipping along the ventral face but there is severe rounding, and although difficult to observe due to the edge's angle, microchipping on the distal

edge of the dorsal face was observed. In hide scraping experiments it was found that much of the wear was centered along the dorsal surface of the distal edge, even though it was the ventral face of this edge that buttressed against the worked material (Hayden 1979:224). This is not to say that no wear formed on the ventral face of the tool, but rather the gross majority of this wear occurs on the dorsal face. In accordance with Vaughan's experiments, it is likely that the Gowen artifacts were used at a high angle on a material other than hide for the majority of the wear is present on the ventral face. Further, striations created by working hide are the product of trapped grit or sand particles, which are not supported by the morphology of the Gowen artifact striations.

Such a pressure orientated the tool at a 45° or greater angle while it scraped or planed. Further, scraping actions commonly produce unifacial wear that is spread-out over a relatively large area (Salls 1985:103). Such scraping involves pulling a tool towards the body. When a tool is pushed away from the body, it is called planing. More abrasive wear is produced along the distal edge through planing than scraping. Because of the level of abrasive wear found on the Gowen artifacts (flattening of the edge) and given that the striae are orientated vertically, it is very likely that these tools were used to plane as opposed to scrape.

Rounding was also encountered on the Gowen artifacts, similar to other Eldon unifaces discussed here. The similarity was a product of the task and the nature of how quartzite in general wears during use; as was discovered during the experiments where individual grains became dislodged while working antler. This occurs where the material is not as cohesive, although, the process of metamorphism has cemented the quartz grains together, the weak bonds between the grains are broken during use and they become dislodged. This produces uneven and jagged edges on the unifaces.

6.4.4 South-Central Saskatchewan: EgNp-63, Aitkow 3 site

None of the artifacts from EgNp-63 were analyzed under high-power magnification. Only low-power magnification with a dissecting microscope was used for their analysis. The calcium build-up on many of these artifacts hampered the investigation of usewear under a microscope. However in this case the calcium build-up on No. 40 proved insightful. Under the microcope it was noted that a small line of the calcium build-up was missing along the distal edge of the ventral surface (Figure 6.20a and 6.20b). The calcium was

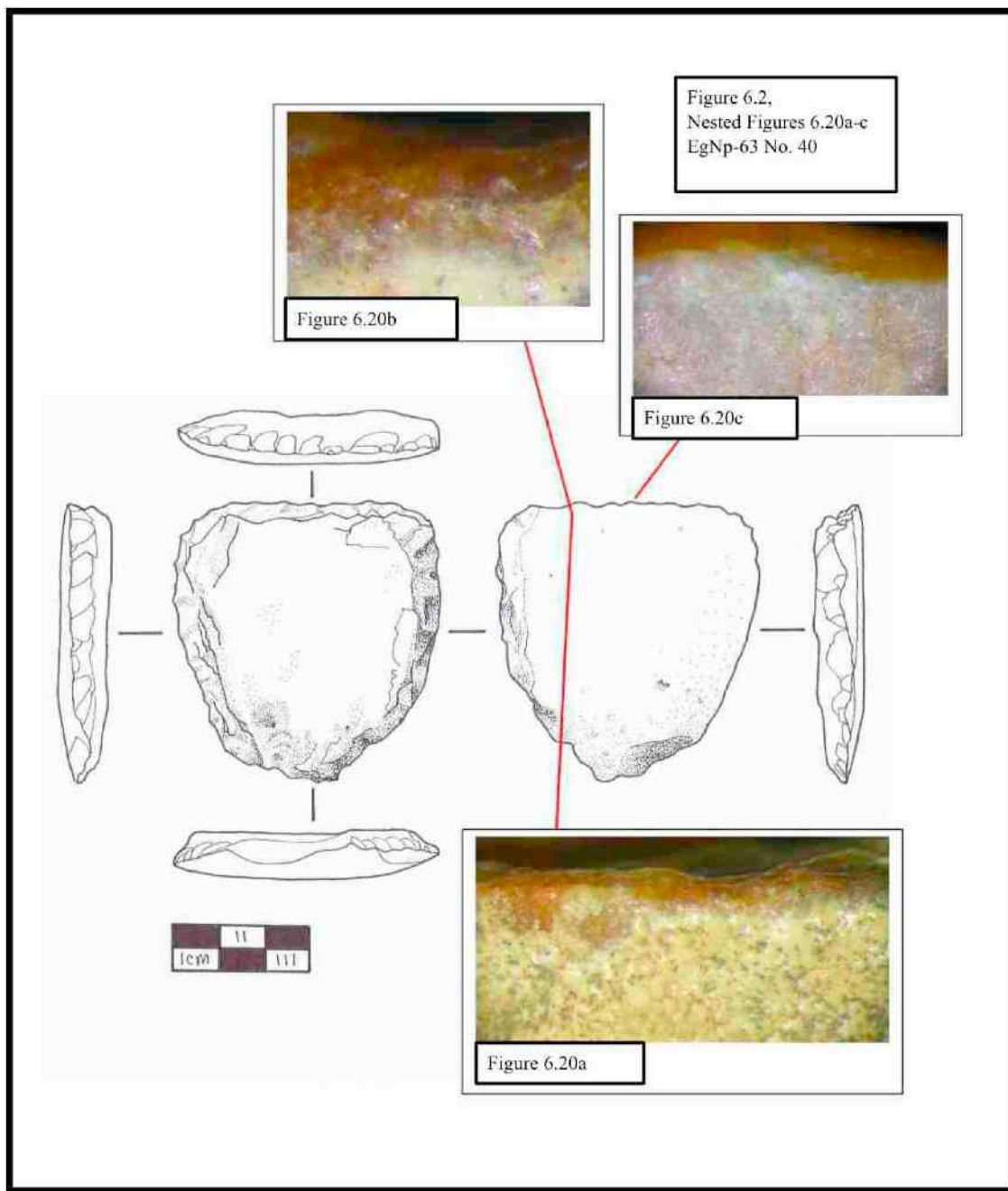


Figure 6.20 Usewear map of No. 40 from EgNp-63. Figures 6.20a-6.20c nested in Figure 6.6.

observed at 6.5x magnification and was likely removed during the tool's use since the build-up was thinner near the working edge and the edge itself was also equally worn. As a comparison to Figures 6.20a and b, Figure 6.20c shows how the right part of the edge does not have calcium build-up and yet is similarly worn.

Not all of the EgNp-63 artifacts appeared worn. In particular, No. 26 (a Corner Eldon uniface) had little evidence of use. For one, there were no visible retouch scars. The working edges were sharply defined with no softening of the edges or rounding of the projections. In contrast, No. 6 from EgNp-63, also a Corner Eldon uniface, had wear traces similar to those on the Gowen site artifacts. This wear consisted of a slight rounding along the edges and associated microchips (Figure 6.21, with red-dashed oval



Figure 6.21 Rounded and crushed projection along Eldon uniface No. 6 from EgNp-63 (16x magnification).

overtop of rounded area). The high-relief on the dorsal surface was additionally worn and softened to such a degree that it was noticeable without the aid of magnification. Such dorsal high-relief wear was similarly noted on No. 131 from the Gowen sites.

6.4.5 South-Central Saskatchewan: EgNn-9

No. 56 from the EgNn-9 site was analyzed with a low-power approach. This artifact was very similar in morphology and usewear to the EgNp-63 artifacts. The artifact's distal edge was steeply retouched, slightly rounded, and crushed (Figures 6.22a and 6.22b). Projections along this edge had the most severe rounding. There were also numerous microchips along this edge, although the type of scar termination was difficult to distinguish. Lastly, there was also a small degree of edge rounding along the proximal edge of the dorsal face (Figure 6.22c).

6.5 Discussion /Conclusion

In the author's opinion, there are three important factors to consider with respect to tool motion: direction of movement, drag, and resistance. This is shown in Figure 6.23, where a curved and dotted arrow represents drag, the right facing arrow the tool's movement, and the left facing arrow below it represents resistance. The images on the right are of two hafting methods: *L* haft (center) and straight haft (right). Direction of movement is self-explanatory. Resistance is the consideration of the worked material's density. The harder the material the more resistance it will give to the tool working it. Drag is the weight and pressure that is provided by the tool and the tool's user that pushes the tool into the surface of the worked material. While a material's resistance will remain constant, the effect of drag determines how much of the material's resistance will enact; for example, there is a noticeable difference in softly running a finger across a material versus pressing firmly down while still moving a finger across a material. The direction in which Eldon unifaces were employed can be indicated by the above usewear discussion and is explained below. The resistance is more difficult to determine, but some generalities can still be offered, and are, below. Drag, however, is much more difficult to show and is a concept that would be ideal for future studies.

The type of material that the artifacts processed is difficult to discern. Future comparative experiments using a SEM may help clarify this. Nonetheless, a general material type can be argued, one that is medium to hard density material. Soft materials are argued against since the degree of rounding and crushing on the distal edges is more severe than what would accrue from working soft materials. However, if these tools were

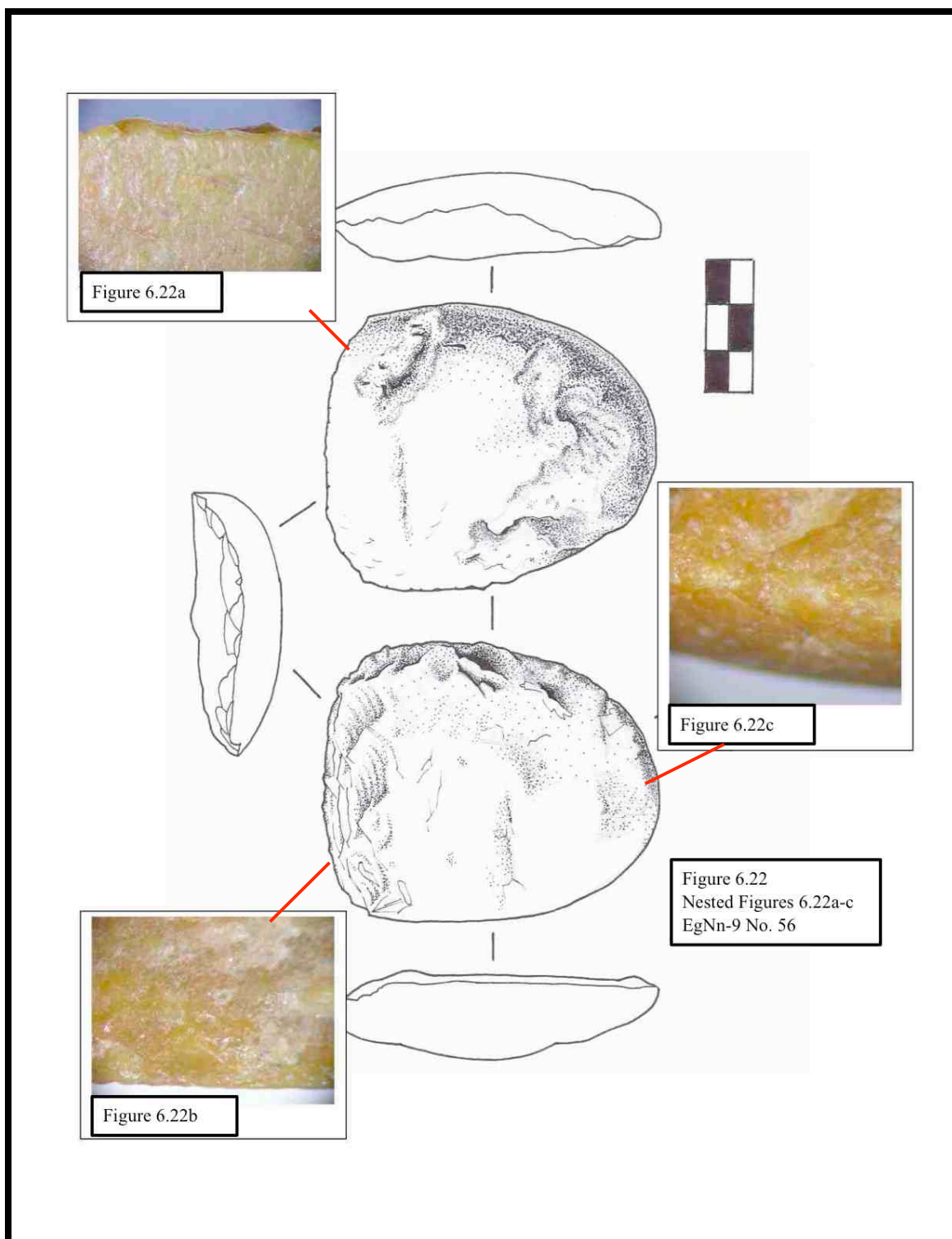


Figure 6.22 Usewear map of No. 56 from EgNn-9.

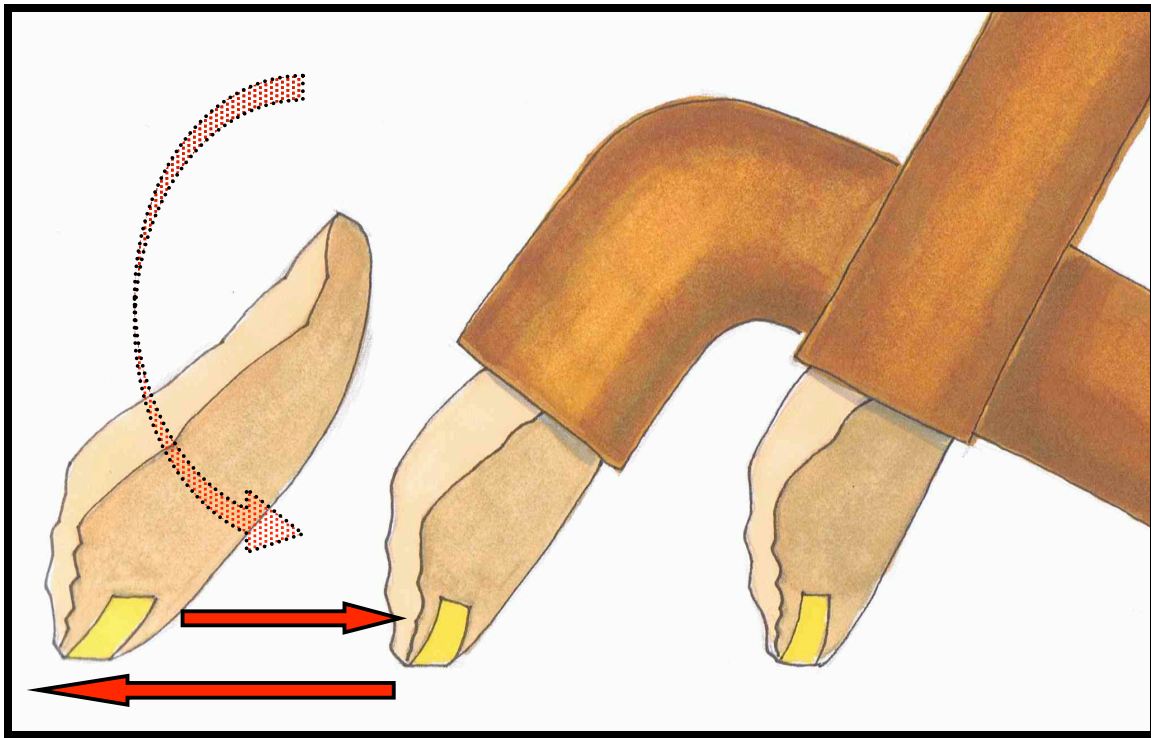


Figure 6.23 Eldon uniface movement and two possible hafting styles.

curated for several generations like the Tahltan tools, then a softer material may have produced this wear (see Appendix A for further differences between material wear types and the effect of time upon wear). Further, the flattening of some edges is more likely to develop from processing medium-hard to hard materials and is supported by the results of using experimental flakes on wood. Wood and antler were chosen in the experiments because it was reasoned that these tools were used on such hard materials. The descriptions in the literature of usewear from such medium to hard materials in addition supported this approach. Wood is the more likely of the two as the usewear from the experimentally used flakes more closely matches that of the artifacts, and it is indicated through the experiments that quartzite might be a poor lithic material to work antler. Dried hide, on the other hand, may likewise be a suitable material that was not tested. Dried hide is considered a medium-hard material, although the rounded striations do imply wood rather than hide, as discussed previously. One argument against dried hide, nonetheless, is the fact that the polish was not frosted and seemed brighter than would be

expected for hide (see Appendix A, section A1-1 for more information on the differences between polish types). Instead, the polish more closely matches descriptions of wood polish, although further research with a SEM would allow for stronger polish characterizations and hence inferences. In addition, there was nothing from the usewear study to support the artifact's cortex surface being used to rub a hide. Polish was found on the central portion of the cortex surface, but was associated with a much larger patch that was orientated in such a way as to link it with hafting wear.

One of the more interesting and obvious usewear observations made on the Eldon unifaces was that the distal edges of some of the artifacts were striated and worn flat (Appendix A, section A-1.4 also discussed this form of wear). Flattening of the edge was not circumscribed to only one tool type, but was found on both Classic and Corner Eldon unifaces, most notably at the Gowen sites but to a lesser-degree the Aitkow 3 and the HhOv sites. This observation indicates that these tools were either pushed or pulled in one direction since the striations do not cross. The latter occurs when a tool is moved in a back-and-forth motion. Further, the flattened edge indicates that the tool was held at an angle to the worked material. This is because when the artifact's flattened working edge is rested flush against a flat surface, it orientates the artifact at an angle, hence why the artifact in Figure 6.23 is illustrated at an angle. Such an orientation would likely occur with a stone tool that was hafted in an *L*-shaped handle because it automatically angles the tool; however, a straight handle could also have been used but would perhaps be more awkward to use as it was held at such an angle (Clark 1974; Whittaker 1994).

The location of microchipping also helps to determine whether it was the dorsal or ventral side of the hafted tool that faced towards the worked material. Microchips (as discussed in the Appendix A) more frequently form on the opposite side to where the edge pushes or scrapes into a material (Odell and Odell-Vereecken 1980; Vaughan 1985). For all the artifacts discussed above, from both Alberta and Saskatchewan sites, microchips were far more common on the dorsal face of the distal edge, although difficult to characterize. According to the literature, this would indicate that it is likely that the ventral surface of an Eldon uniface faced forward while being pulled towards the user's body when working a material. The problem with this, however, is that the distal-ventral edge is smooth and not steep like the dorsal's distal edge. There are two possible

explanations for this. One is that such an edge was valued for use in working dried hides, which as stated previously could produce medium hardness wear and had not been tested for during the experiments here. Such a smooth edge would be valued, as it would not tear a hide. Further, dull, broad, and large edges are ideal for working hides because they “grip slippery surfaces... [and soften] large areas at once” (Hayden et al. 1996a:32), which supports the usage of these tools to work hides. Yet, the role of woodworking cannot be discarded. The second explanation perhaps supports the role of woodworking, as it is possible that both sides of the edges were in fact microchipped at one time, but the flattening of the edge erased these chips. In this scenario the tool might have been pushed at an angle away from the body, planing the wood. For this to occur, it would be less awkward to have used a straight handle. In regards to function, there is furthermore no reason as to why Eldon unifaces could not have had more than one function. Usewear of multiple functions are difficult to distinguish, as it is only the last function that is commonly retained on the distal edge.

A possibility is that Eldon unifaces were used to work both wood and hide, as argued by the morphological similarities in the earlier discussed Tahltan artifacts (Albright 1984). Their cobble spall tools (CST) were used to process both wood and hides, and this duplicity in function might explain why there is confusion over the function of CSTs in the southern interior of British Columbia (eg. Grabert 1979:171; Hayden et al. 1996a:29; Morin 2004; Rousseau 2004); there was not just one function for the tools. Although, what was not tested here was the length of use to compare these two artifact types. The Tahltan CSTs were used for 100 years or longer (Albright 1984:58). Such a length of curation and use would produce significant levels of wear; as mentioned in Appendix A time is a crucial factor in how wear develops. It is therefore feasible that if a tool processed a soft material for as much as a century that the wear could develop to the same degree as a tool used to process a harder material over a shorter period of time. Also in regards to hide working, the smaller Tahltan CSTs were used to process small hides, and vice versa for the larger CSTs (Albright 1984:57-58). This might explain the variation in Eldon uniface size at the Gowen and other sites, or the differences in size of the Corner and Classic Eldon unifaces. A further note is that this study would be greatly

aided by a comparative usewear study of CSTs from British Columbia. This was not possible in this thesis, but would be a worthwhile future endeavor.

A chopping action for Eldon unifaces can be discounted, as this form of task produces equal amounts and kinds of damage to both sides of the working edge. Instead, the flattening of an edge requires the tool to be in constant contact with a worked material as one side of the edge glided atop the worked material. Flattening of an edge in general does not happen during chopping, and instead the more prominent form of damage is a severe blunting of the working edge and microchipping that occurs on both sides of the edge, giving it a bifacial look.

As proposed above, Classic Eldon unifaces were likely hafted on a *L*-shaped handle (in addition called an elbow haft). There are two ways this may have been done. One is by strapping the tool to either the top or bottom of the haft. This method is shown in Figure 6.24, and the labeled A and B curves on the right represent how the tool might be hafted either on the top or bottom of the handle. The other way is by inserting the tool inside an open-socket *L* or straight handle (Figure 6.23). Tools that are attached to the outside of a handle often form thick polished lines where the tool rests upon the handle (Brownlee 1995). Such a polish was not observed on the artifacts, but instead a more general wear and polish across both surfaces; this differs from how cobble spall tools from BC were hafted because they were inserted into a straight socket haft as shown earlier in Figure 3.25 of Chapter 3, section 3.5. The severe rounding on many of the flaked dorsal surface high-spots might, however, support the idea that the tools were strapped to the surface of a handle. Such rounding would likely not be the product of a soft substance like a binding but rather from grinding on a hard material like a wooden or antler handle. This would imply that the dorsal surface faced down against the handle. Furthermore, rough and un-ground edges like those found on many of the Eldon unifaces are often associated with elbow hafts where the rough edges aid in the binding (Brownlee 1995). Tools inserted into socket hafts, instead, have smooth lateral margins that are less common on Classic Eldon unifaces but more common on the Corner Eldon unifaces.

Corner Eldon unifaces have two opposing modified edges, similar to the bi-pointed adzes of Manitoba. For the Corner Eldon unifaces, two opposing edges were utilized and

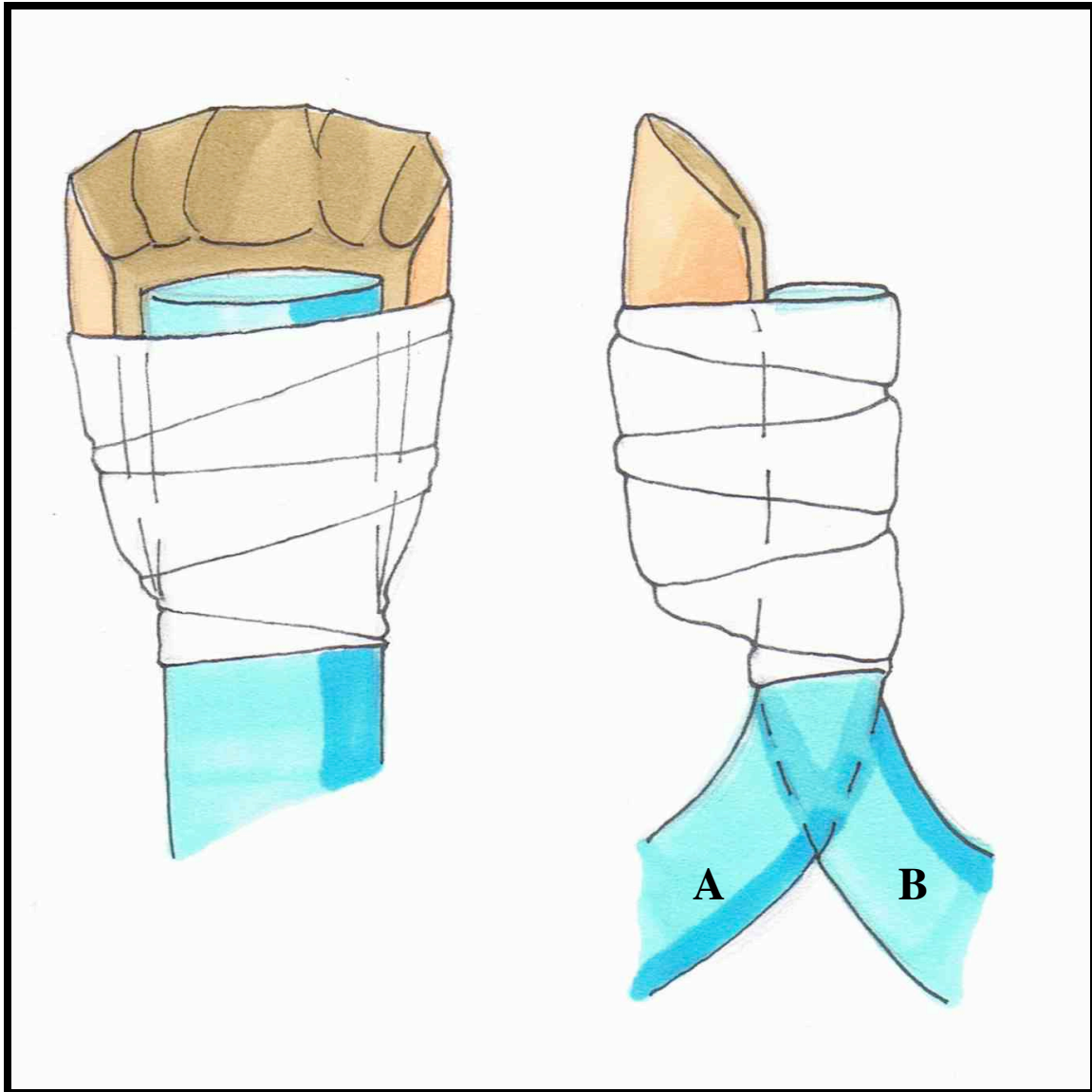


Figure 6.24 Hafting style of Classic Eldon unifaces.

one lateral edge was sometimes flaked to thin the edge for hafting; the opposite lateral edge retained the striking platform. Wear traces, primarily rounding, flattening of the edges, crushing and microchipping was found on both lateral edges, however, not all the specimens had wear on both these flaked edges. The distal and proximal edges were flaked during one singular episode of manufacture instead of one lateral edge flaked, used, rotated, and the opposite lateral edge then flaked and used. Therefore, only one edge was used at a time while the other was not.

There are two possibilities as to how Corner Eldon unifaces were hafted. One is that a split haft or open-socket haft was used. In the case of a split haft, the flaked lateral edge would be inserted down into the haft with the two opposing working edges sticking out. The two ends of the haft would then been tied together to secure the tool. A problem with a split-haft is that tools used for intensive tasks such as working wood do not last long when an split haft is used as the handle often splits open after 8 to 10 blows (Brownlee 1995). For an open-socket haft, the tool might have been inserted into a hole drilled through the handle and secured with resin and /or bindings. Both these scenarios would have the tool forming a *T* or *t* shape. A second possibility is again an open-socket style, but this time using either an elbow or straight handle (Figures 6.23 and Figure 6.25); this time similar to cobble spall tools from BC. In either case, the flaked proximal edge would have been inserted into the hole of the haft and secured with resin and /or bindings. Such a scenario would produce wear on the flaked proximal edge and it could be that the wear viewed on the artifact edges is from such hafting and hence the edge modification was not for future use but to aid hafting. This second scenario is the most likely, as it would provide the greatest amount of support for a tool used to process hard materials. It is unlikely that the tool was dislodged from the haft while in use and the proximal edge's shape supports this idea. Still, the modification to one lateral edge is curious as it has little sign of use, although it might be related to the processing of a material. However, as discussed earlier, hafting wear is uncommon as a good haft should not leave much wear and so the wear is more likely from use. Nonetheless, further research with high-magnification microscopy and with more newly found Corner Eldon unifaces would likely better answer the question of if both proximal and distal edges were worn from use or from hafting and use.

Thus far, this chapter has focused on individual artifacts, artifact types, and sites. There are also pertinent inferences to be made about the differences and similarities between artifact types at the various sites. One observation is that the smoothed distal edges are not limited to only one Eldon uniface type. Both Classic and Corner Eldon unifaces have flattened distal edges, and the other types of wear traces are grossly similar between these two types. This strongly indicates that while these two tool forms have important and obvious morphological differences, their function was very similar. The

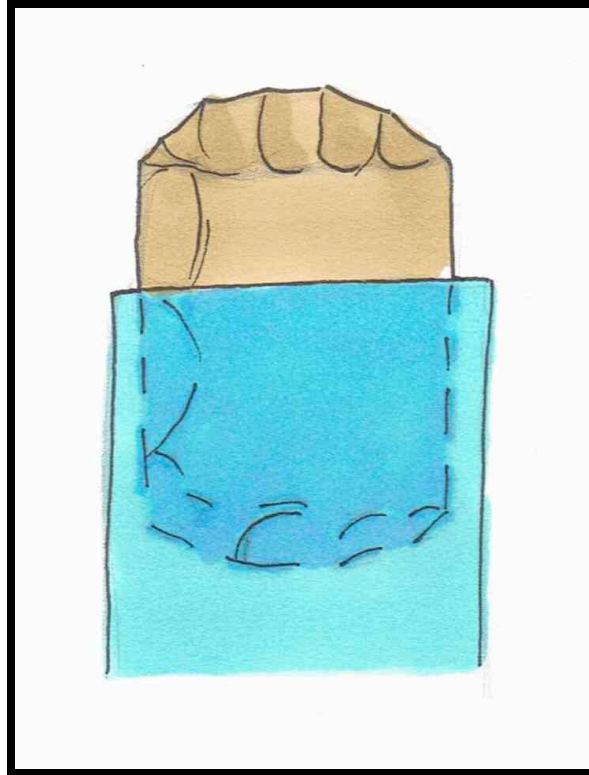


Figure 6.25 Hafting style for Corner Eldon unifaces.

reason for such a morphological difference might be due to cultural preferences rather than task differences. However, Classic Eldon unifaces were clearly not transformed into Corner Eldon unifaces. The Classic sometimes have the striking platform removed, and the tapered proximal region does not allow for a Corner Eldon uniface shape to be made from it. Further, in regards to a cultural rationale, both tool forms are associated with one another at the same sites and so were evidently the product of a single cultural tradition. Some other possibilities for the differences may include variations in status or gender of those using the tools; making or processing different objects, although the materials were the same and worked in similar ways; or simply individual taste in how to construct one's tools (much like how there are differences in material goods today that have the same function, like cell phones).

A second point is that there is a noticeable difference between the usewear found in the Alberta sample and that of the Saskatchewan sample. This is a difference of usewear severity, where the flattening of the distal edge is evident across Saskatchewan but only at the HhOv sites for Alberta sites, and this is much weaker at the HhOv sites.

Crushing of the dorsal surfaces and the amount of distal edge resharpening was also more prominent at the Gowen sites than the Alberta sites. This difference of severity might be a product of a difference of curation, where Eldon unifaces were used over a longer period in Saskatchewan than Alberta. It cannot be suggested, though, that the FgQf-16 artifacts were resharpened more frequently than the Saskatchewan tools as both artifact collections have similar length and width ratios. If the FgQf-16 artifacts had been resharpened more often, and hence removed the flattened edge, then their length-width ratios should be much smaller than the Saskatchewan assemblage, as resharpening reduces a tool's length but not its width. The reason for this difference is instead a difference of mentality. As mentioned in Chapter 3, the faunal material at the Gowen site was utilized to its utmost potential. This frugality, more broadly considered not just for the Gowen site but rather the period of time associated with the Altithermal might have been expressed in other avenues of the culture such as stone tool technologies. Therefore, stone tools such as the Eldon unifaces were used to their fullest potential before discard, producing dramatic usewear and skewed metric attributes (sizes) in comparison to other sites. An apparent difference of mentality between FgQ-16 and the Gowen site, even though they are of the same time period (early-Middle Period) might be evidence of ethnic or cultural group differences or perhaps the environment was not as harsh in western Alberta as it was in southwestern Saskatchewan. Nonetheless, the similarity of use between EgNp-63 and FgQf-16 might support a cultural difference.

Another explanation might be that the Alberta artifacts were used on softer materials than their Gowen counterparts; a difference of function. Perhaps those harder woods were worked in Saskatchewan. Nonetheless, if further usewear testing instead indicates that the Saskatchewan tools were used to work dry hide, then perhaps the Alberta tools were used to work soft hides instead. In New Guinea, aboriginal groups continue to use stone tools for the crafting construction of wooden objects (Sillitoe and Hardy 2003). Stone tools are used as a transitional tool of sorts, where a stone flake is used to make a non-lithic tool. This usage of stone is likely not unique to New Guinea aboriginals, but rather found throughout the world. For instance, the Chapter 5, section 5.2.2 discussion of Sioux hide working was an example where stone is used to process skins. It is the hide that has pertinence, permanence, and likely greater meaning in the

Sioux society. The reason why archaeologists instead place greater importance on the stone tool rather than the hide, is that it is the stone and not its products that survives in the archaeological record. For instance, a hammer in contemporary society is not as highly valued as the house it builds, and yet it would be the hammer and not the house that has a higher archaeological visibility and hence would receive the greater amount of attention for the archaeologist and in turn the consumer of archaeological lore. This simple premise seems to be all too commonly forgotten by archaeologists and further supports the importance of usewear studies.

A final comment on the usewear analysis is that while the high-power approach allowed for a limited discussion of the artifact polishes, the dorsal surfaces of the tools were readily studied with the low-power approach. This relates to the 'forest through the trees' idea, where the high-power approach is focused too much on individual crystals. Crushing and rounding were found to be the most informative aspects of wear on the flaked, dorsal surfaces. The low-power approach allowed for a large area of these surfaces to be examined resulting in a better comprehension of what the wear meant, especially since crushing was best identified with the low rather than high-power microscopy. In the future, the high-power approach in the guise of a SEM would best be directed at analyzing the cortex surface for polishes, only. The low-power approach should instead focus on wear features such as crushing, chipping, and rounding that is evident on either flaked or cortex surfaces.

Chapter 7

Conclusion

This thesis expanded and tested ideas associated with Eldon unifaces, and presented new inferences about this artifact type. These artifacts have been named Eldon unifaces, after the late Eldon Johnson. This thesis additionally has investigated the function of these tools through two means of analyses: morphological and usewear studies.

Change in morphology and meaning is expected to occur across time and space. Therefore it should also be expected that variation occurs in a typology like that proposed here for Eldon unifaces, hence the adoption of Boast's (1997) fuzzy categories. This variation is strongest *within* the individual four types, but weakest *between* the four types. This links the four artifact forms. The four types proposed are: Classic, Corner, Side, and Amorphous Eldon unifaces. Five characteristics glue these types together, although further similarities were indicated during the morphological, sequence model, and functional analyses. The first of these characteristics is that the tools are constructed from a bipolarly split cobble flake. Second, the blanks are a patterned edge modification with an attempt to thin (successfully or not). Third, the cortex is entirely retained across one surface of the tools. Fourth, these tools are mainly made from quartzite, particularly Rocky Mountain Quartzite. The only exception to this fourth statement is found at the Gowen site and EgNq-18 sites. Fifth, Eldon unifaces tend to be the size of a fist or slightly larger, with the Gowen assemblage slightly smaller. The exceptions that are found in the Gowen assemblage were explained in Chapter 4 as a product of environmental constraints where larger cobbles and cobbles exclusively comprised of quartzite, were likely not available in large numbers. Eldon unifaces are likely related to workshops where large numbers of tools were needed for multiple people working on one large project.

Eldon unifaces discussed in this thesis were obtained at sites in Alberta and Saskatchewan. As indicated in Chapter 3, they are not known from northern or eastern Saskatchewan, but are spread across the entire province of Alberta including the Plains and boreal forest. Eldon unifaces date to the early-Middle Period. The sites in which they were found were habitation sites, near water sources and treed areas. Roe (2009:94)

believed that these artifacts were “were most likely made, used, and discarded in the same place”. Instead, it was argued that they likely represent the scale of the task in which they were employed. Numerous people may have been involved in one particular task at one particular time, and this task might have been repeated the following year. Having large and cumbersome tools for future use instead of being remade or transported would benefit such a task. Furthermore, as was discussed in Chapters 4 and 6, quartzite is a very tough toolstone that takes a considerable period of time to wear. It would therefore be illogical that so many tools of such a hard toolstone would be required for one short task.

In Chapter 3, similarities were noted between Eldon unifaces and artifacts from Eastern Woodlands /Maritimes, Manitoba and British Columbia. Spall tools and chipped hammerstones from the Eastern Woodlands /Maritimes share similarities with Eldon unifaces, but were provided brief descriptions in the literature, limiting what can be said. Adze blades in Manitoba similarly share some similarities in morphology but not in material type or the retention of cortex; however, the retention of cortex could be considered a natural form of polish. In particular, trihedral adzes share some attributes with three artifacts from EgNp-63, and bi-pointed adzes are similar in description to Corner Eldon unifaces. British Columbian artifacts were even more similar in morphology, construction, and the types of sites they were associated with. These tools were referred to as cobble spall tools and they were separated into two related types. The first was a Palaeoindian period cobble spall tool noted on the Northwest Coast. This had minimal edge retouch and shared similarities only in that a bipolarly split quartzite cobble flake was used as a tool with the retention of 100% of the cortex on one face. The second type was noted from the interior of the province. This was manufactured in exactly the same way with bipolar percussion, patterned edge modification, and retention of cortex across one surface. The tools were found at habitation sites, cached, and at the Keatley Creek site, curated and stored along the walls of house pits. The function of the tools is uncertain as some authors suggested a hide processing function while others claimed fish processing (specifically beheading of fish), and others subscribed to a wood working function. Again, there is a possibility that the function for cobble spall tools and Eldon unifaces were similar for they both may have been used for multiple tasks. Eldon

unifaces are only associated with early-Middle Period dates while cobble spall tools date to the entire spectrum of the regions history. Further, there are four identified types of Eldon unifaces. Cobble spall tools are described as more uniform but this may be a product of how the tools have been studied rather than what actually is there.

Chapter 4 provided a discourse on design theory and sequence models. The models were used to articulate a discussion on how Eldon unifaces were made and why quartzite was chosen. Design theory was used to discuss artifact design in terms of constraints involved in making and using an object. Sequence models were used to look at the choices made in constructing and using tool. These two approaches are complimentary. The proposed method of Eldon uniface manufacture is idealized, as the previously mentioned *inside-out* approach argued for variability within a structured framework; the idealized method is such a framework.

The method of Eldon uniface construction was separated into four steps. The first was collecting raw material. This topic was expanded by an examination of analogies from ethnoarchaeological studies of how raw stone was treated in traditional societies. The second step was to bipolarly flake a cobble by bracing an upright cobble in some way allowing the flintknapper to use both hands to freely swing a hard hammer to achieve accurate and predictable breaks. This step was furthermore likely the most difficult process and required the greatest amount of skill. Using recycled FBR to manufacture Eldon unifaces was another option proposed. The third step was to remove large flakes along the distal and lateral edges to shape and thin the piece. Rarely were flakes removed from the proximal edge. This especially pertained to the Classic type while the Side type required modification of only one lateral edge. The Amorphous type had all edges modified, and the Corner type had two lateral edges flaked. The final step was the removal of small sharpening flakes along the distal edge and sometimes the laterals margins, plus edge grinding to aid in hafting.

Eldon unifaces did not likely require much time to construct, although a handle /haft would require more. Therefore, in relation to a value of time, the handle was likely worth more than the stone tool. Either men or women may have made and used these tools and the process of learning to make them was discussed in terms of scaffolding. This learning would produce variability in the typology /assemblages as there were likely

differences in morphology between a student and teacher making Eldon unifaces, especially with the initial bipolar splitting of the cobbles.

The function of Eldon unifaces was broached in Chapter 5. This chapter addressed artifact function through a study of morphological traits as interpreted by the archaeological literature. This research demonstrates disagreement in the literature, especially in the context of what edge angles implied. Nonetheless, when a number of traits were analyzed together, the majority indicated that the tools had been used to work medium to hard materials like bone or wood. Further, a strong argument for hafting was based upon the morphological data.

In Chapter 6, a usewear analysis of Eldon unifaces began with a brief description of what usewear research is and how analogies are employed. The usewear analysis of the artifacts followed this. This focused on artifacts from the excavated sites and predominantly the Classic and Corner Eldon uniface types. The usewear was similar to that of tools used on wood, although in hindsight, dried hide might also be a possibility. Flattened distal edges proved to be the most intriguing of the artifact observations. These indicated that the tools were held at an angle to a material that they planed, or less likely, scraped. Striations on these flat areas were parallel, few, and had rounded troughs, likely produced from projections on the worked material and not from foreign particles like grit that would appear while working a hide. Further, this usewear was found on both Classic and Corner Eldon unifaces, indicating that although the physical attributes were different, the function was the same. This usewear, however, was not mirrored in Alberta, except to a minor degree at the HhOv sites. This connoted either that the Hinton tools had not been used to the same degree or they had a different function.

Summarily, all but the Side and, perhaps, Amorphous Eldon unifaces were hafted tools used to plane a material of medium to hard density. This material was likely wood. The artifacts were recovered from habitation sites that date to the early-Middle Period. The tools were further curated and cached at these sites and likely pertained to tasks that required numerous tools for their completion, and in hand with this, numerous people. The sites were from southwestern Saskatchewan and across Alberta, with interesting differences separating the assemblages from the two provinces that might pertain to a functional difference and perhaps indicated slight alterations in transference of

knowledge as it traveled across a large area. The dissimilarity at the Gowen site might represent a general frugality rooted in how people engaged in their subsistence economy, along with the technological focus, product of the cobble size available in the area. In all, the function of Eldon unifaces may have been multiple, including processing soft wood and /or dried hide. A complicating factor is that similar tools from British Columbia were used for multiple generations to process hides, which could result in usewear similar to that produced by working harder materials like wood. Additionally, limited morphological similarities with other tool forms outside this region were found. The British Columbia connection may represent a similar technological adaptation to a given problem. This was the strongest connection and deserves more research.

Future Direction

There are two aspects to this thesis research that can be expanded in the future. These deal with sample size. More Eldon unifaces will help to strengthen and develop the proposed definitions. This will also help to identify the extent of the geographical distribution of the artifacts and would better indicate how the knowledge of these tools was spread across the landscape; especially in eliciting what these artifacts' role was in the boreal forest of Alberta. It is very likely that groups in the northern United States additionally made these tools.

Finding more Eldon unifaces in datable contexts would also allow for a study of functional change over time. For instance, Buffalo Bird Woman noted that the way in which people butchered bison in her day differed from the ways in which they were butchered prior to European contact (Brink 2004). While this difference can be shown in analyzing faunal cut marks, does this difference additionally appear on stone tool usewear? In particular, the stone tools that Buffalo Bird Woman used were the same as those used prior to the contact period. If usewear does differ on a stone tool such as a scraper, could this then be true for other stone tools? Stone tool usewear can be used to infer not only what type of material was manipulated but similarly the motion. Would, then, evidence for tool motion change on a stone tool over time even though the morphology and type of material the tool was used on stayed the same? Or would evidence of changes in tool motion and other factors be inferred instead as the product of individuality in the archaeological record and not a change of cultural traditions? I

believe if a study of stone tool usewear showed a consistent and patterned change of motion or other factors while the tool's morphology and evidence for what materials were manipulated by the tool remained constant, then one may be able to infer that there was a change in cultural tradition. This is doubly important because, through usewear, this may be the only way to infer such cultural change in the archaeological record as it may not be readily apparent in stone tool morphologies alone, such as projectile point styles that are typically used to infer culture change in archaeology.

The second aspect is that the usewear experiments and analyses can be expanded. For the experiments, the utilization of quartzite on various materials would aid usewear analysis in general. An experiment on processing hide would in particular aid the understanding of Eldon unifaces as this can prove or discount the possibility that these tools were used on hide; as it stands, the use of Eldon unifaces on hides is remote but still possible. Usewear analysis of Eldon unifaces would likewise be aided by the application of a variable pressure SEM. This would allow for better characterizations of both striations and polishes. Another application would be the experimental use of a 3-D scanner. This would aid in the quantification of metric attributes and possibly in identifying usewear in an objective manner that is not currently allowed for in usewear studies. The application as a whole of 3-D scanners to usewear research holds much interest as the range of magnification in this form of equipment has rapidly increased over the past few years, reaching the point where striations and microchips can be observed. This process would also make usewear analyses much faster as the major time cost would involve scanning and cleaning the data. Following this, a 3-D model of the tool's surface could be analyzed at the researcher's convenience and the limitations of a reflective and slanted surfaces would be erased.

There have been a number of important advances in computer scanners, especially in how these scanners can now produce 3-D images of a sample's surface. These images have high resolution and magnification that originally was intended for industrial applications and has recently been applied to archaeological usewear interests (Astruc et al. 2003). The drawback to this is that because it is a new technology it is not readily accessible for archaeological researchers. Furthermore, this is an expensive technology that requires substantial expertise from computer scientists. Yet, the results from this

form of analysis can be highly informative, as explained by a recent study of chert tools from 7,000 BC, Cypress. These stone tools were used to work other stone materials to produce stone vessels and pieces of art /adornments (Astruc et al. 2003). The researchers noted that the working of chert against specific types of stone commonly used to shape items like vessels leaves diagnostic wear traces, which in their words can indicate a “given socio-economic context” for those chert artifacts (Astruc et al. 2003:341).

Experiments were conducted whereby a piece of chert was worn against materials such as diabase and picrolite that were used to make vessels. This experiment was a scratch test, where a piece of chert was stabilized on a surface and the diabase or picrolite was fitted into a diamond indenter, which moved the diabase or picrolite upon the chert while measuring and maintaining constant variables such as load, strain, force, and angle of movement. The worked chert was then removed and digitally scanned, with magnifications of 500x provided. While many usewear experiments look at much larger magnifications with the aid of SEM's, the scan's 500x magnification nonetheless provided convincing evidence for abrasive wear in the form of rounding and straiæ. Furthermore, the chert's surface topography was mapped before and after the experiment. The heterogenous nature of the unaltered (pre-experiment) chert surface was compared to the altered chert surface, resulting in evidence for a reduction in surface topography: what the authors refer to as a reduction of *peak heights*.

References Cited

Ackerman, Robert E.

2007 The Microblade Complexes of Alaska and the Yukon: Early Interior and Coastal Adaptations. In *Origin and Spread of Microblade Technology in Northern Asia and North America*, edited by Y.V. Kuzmin, S.G. Keates, and C. Shen, pp.147-170. Archaeology Press, Simon Fraser University, Burnaby BC.

Ackerman, Robert E., T.D. Hamilton, and R. Stuckenrath

1979 Early Cultural Complexes on the Northern Northwest Coast. *Canadian Journal of Archaeology* 3: 195-209.

Adams, Brian

1999 Lower, Middle, or Upper Palaeolithic? A Classification Analysis of the Barsony House Hand Axes from the North Carpathian Basin. *Lithic Technology* 24(1): 7-26.

Adams, Jenny

1988 Use-Wear Analyses on Manos and Hide-Processing Stones. *Journal of Field Archaeology* 15(3): 307-315.

Albright, Sylvia L.

1984 *Tahltan Ethnoarchaeology*. Department of Simon Fraser University, Department of Archaeology, Publication Number 15, Burnaby, British Columbia.

Anderson, H.H., and H.J. Whitlow

1983 Wear Traces and Patination on Danish Flint Arefacts. *Nuclear Instruments and Methods in Physics Research* 218: 468-474.

Anderson, Patricia C. and Jacques Chabot

2001 Functional Analysis of Glossed Blades from Northern Mesopotamia in the Early Bronze Age (3000-2500 BC): The Case of Tell 'Atij. *Journées d'Etude du Goupe de Recherches en Archeometrie du CELAT* 10: 257-276.

Anderson, Patricia C., J.-M. Georges, R. Vargiolu, and H. Zahouani

2006 Insights from a Tribological Analysis of the Tribulum. *Journal of Archaeological Science* 33: 1559-1568.

Anderson-Gerfaud, Patricia

1988 Using Prehistoric Stone Tools to Harvest Cultivated Wild Cereals: Preliminary Observations of Traces and Impact. In *Industries Lithiques: Traceologie et Technologie*. Edited by S. Beyries: 175-195. *British Archaeological Report*, International Series 411(1), Oxford.

Andrefsky Jr., William

1994 The Geological Occurrence of Lithic Material and stone Tool Production

- Strategies. *Geoarchaeology: An International Journal* 9: 345-362.
- 1998 *Lithics: Macroscopic Approaches to Analysis*. Cambridge Manuals in Archaeology, Cambridge.
- Archer, David J.
2001 Village Patterns and the Emergence of Ranked Society in the Prince Rupert Area. In *Perspectives on Northern Northwest Coast Prehistory*. Edited by J.S. Cybulski: 203-222. Archaeological Survey of Canada, Ottawa.
- Astruc, Laurence, Roberto Vargiolu, and Hassan Zahouani
2003 Wear Assessments of Prehistoric Instruments. *Wear* 255: 341-347.
- Bamforth, Douglas B., and Nyree Finlay
2008 Introduction: Archaeological Approaches to Lithic Production, Skill, and Craft Learning. *Journal of Archeological Method and Theory* 15:1-27.
- Banks, William E., and Marvin Kay
2003 High-Resolution Casts for Lithic Use-Wear Analysis. *Lithic Technology* 28(1): 27-33.
- Beaudoin, Alwynne B.
2003 Climate and Landscape of the Last 2000 Years in Alberta. In *Archaeology in Alberta: A View from the New Millennium* Edited by J.W. Brink and J.F. Dormaar: 10-45. Archaeological Society of Alberta, Medicine Hat, Alberta.
- Belitz, Larry
1974 *Step-by-Step Brain Tanning, the Sioux Way*. 2nd print. Pine Ridge Indian reservation, Sioux Press, Hot Springs, South Dakota.
- Berman, Mary Jane, April K. Sievert, and Thomas R. Whyte
1999 Form and Function of Bipolar Lithic Artifacts from the Three Dog Site, San Salvador, Bahamas. *Latin American Antiquity* 10(4): 415-432.
- Binneman, Johan and Janette Deacon
1986 Experimental Determination of Use Wear on Stone Adzes from Boomplaas Cave, South Africa. *Journal of Archaeological Science* 13: 219-228.
- Bleed, Peter
2001 Trees or Chains, Links or Branches: Conceptual Alternatives for Consideration of Stone Tool Production and other Sequential Activities. *Journal of Archaeological Method and Theory* 8(1): 101-127.
- Boast, Robin
1997 A Small Company of Actors –A Critique of Style. *Journal of Material Culture* 2(2):173-198.

Bourdieu, P.

1977 *Outline of a Theory of Practice*. Cambridge University Press, Cambridge.

Brantingham, P. Jeffrey

2003 A Neutral Model of Stone Raw Material Procurement. *American Antiquity* 68(3): 487-509.

Brink, Jack

2004 The Lessons of Buffalo Bird Woman: Faunal Abundance and Representation from Plains Oral History. In *Archaeology on the Edge: New Perspectives from the Northern Plains*. Edited by B. Kooyman and J. Kelley: 157-186. University of Calgary Press, Calgary.

Broadbent, Noel D., and Kjell Knutsson

1975 An Experimental Analysis of Quartz Scrapers. Results and Applications. *Fornvannen* 70: 113-128.

Brownlee, Kevin

1995 *An Initial Analysis and Typology for the Adzes from Northern Manitoba: The 1994-1995 Churchill River Archaeological Project*. Unpublished Report.

Buchner, A.P.

1979 *Final Report No.8 The 1978 Caribou Lake Project, Including a Summary of the Prehistory of East-Central Manitoba*. Department of Culture, Heritage and Recreation, Papers in Manitoba Archaeology, Winnipeg.

1982 *Final Report No.12 An Archaeological Survey of the Winnipeg River*. Department of Culture, Heritage and Recreation, Papers in Manitoba Archaeology, Winnipeg.

1984 *Final Report No.17 Investigations at the Sinnock Site 1980 and 1982*. Department of Culture, Heritage and Recreation, Papers in Manitoba Archaeology, Winnipeg.

Burl, Aubrey

2007 *Stonehenge: A Complete History and Archaeology of the World's Most Enigmatic Stone Circle*. Robinson, London.

Cahen, D., L.H. Keeley, and F.L. Van Noten

1979 Stone Tools, Toolkits, and Human Behavior in Prehistory. *Current Anthropology* 20(4): 661-683.

Carlson, Catherine

1979 The Early Component at Bear Cove. *Canadian Journal of Archaeology* 3:177-194.

Carr, Philip J., and Andrew P. Bradbury

2004 Exploring Mass Analysis, Screens, and Attributes. In *Aggregate Analysis in Chipped Stone*. Edited by C. T. Hall and M. L. Larson:21-44. The University of Utah Press, Salt Lake City, Utah.

Chang, K.C.

1967 Major Aspects of the Interrelationship of Archaeology and Ethnology. *Current Anthropology* 8(3): 227-243.

Christensen, M. T. Calligaro, S. Consigny, J.-C. Dran, J. Salomon, and Ph. Walter

1998 Insight into the Usewear Mechanism of Archaeological Flints by Implantation of a Marker Ion and PIXE Analysis of Experimental Tools. *Nuclear Instruments and Methods in Physics Research B* 136(138): 869-874.

Clark, Donald Woodforde

1974 *Koniag Prehistory: Archaeological Investigations at Late Prehistoric Sites on Kodiak Island, Alaska*. Verlag W. Kohlhammer, Stuttgart, Germany.

Conaty, Gerry

1977 Excavations at Wentzel Lake. In *Archaeology in Alberta 1976* Edited by J.M. Quigg: 31-36. Archaeological Survey of Alberta Occasional Paper No. 4, Alberta Culture Historical Resources Division, Edmonton.

Crabtree, Don. E., and E.L. Davis

1968 Experimental Manufacture of Wooden Implements with Tools of Flaked Stone. *Science* 159(3813): 426-428.

Cyr, Talina J.

2006 *The Dog Child site (FbNp-24): A 5500 Year-Old Multicomponent Site on the Northern Plains*. Masters thesis, Unpublished, Department of Archaeology, University of Saskatchewan, Saskatoon, Saskatchewan.

Darwent, John

1998 *The Prehistoric Use of Nephrite on the British Columbia Plateau*. Archaeology Press, Simon Fraser University, Burnaby, British Columbia.

David, N., and C. Kramer

2001 *Ethnoarchaeology in Action*. Cambridge University Press, New York.

Deforest, David Scott

2006 *Assessing "Lithic Sound" to Predict a Rock's Ease of Flaking*. M.A. Thesis, University of Missouri-Columbia.

Denig, Edwin Thompson

2000 *The Assiniboine*. Edited by J.N.B. Hewitt. University of Oklahoma Press, Winnipeg.

Dibble, Harold L.

1987 The Interpretation of Middle Paleolithic Scraper Morphology. *American Antiquity* 52(1): 109-117.

Dick, Lyle

2001 *Muskox Land: Ellesmere Island in the Age of Contact*. University of Calgary Press, Calgary.

Dixon, James E.

1999 *Bones, Boats, and Bison: Archaeology and the First Colonization of Western North America*. University of New Mexico Press, Albuquerque.

Dobres, Marcia-Anne

1999 Of Paradigms and Ways of Seeing: Artifact Variability as if People Mattered. In *Material Meanings: Critical Approaches to the Interpretation of Material Culture* Edited by E.S. Chilton: 7-23. University of Utah Press, Salt Lake City Utah.

Dockall, John E.

1997 Wear Traces and Projectile Impact: A Review of the Experimental and Archaeological Evidence. *Journal of Field Archaeology* 24(3): 321-331.

Doll, Maurice F.V.

1982 *The Boss Hill Site (FdPe-4) Locality 2: Pre-Archaic Manifestations in the Parkland of Central Alberta, Canada*. Alberta Culture, Historical Resources Division, Edmonton, Alberta.

Donahue, Randolph E., and Daniela B. Burrone

2000 Lithic Microwear Analysis and the Formation of Archaeological Assemblages. In *Lithics in Action* Edited by E.A. Walker, F. Wenban-Smith, and F. Healy: 140-148. Oxbow Books, Oxford England.

Donahue, Randolph E., Michael L. Murphy, and Lawrence H. Robbins

2002 Lithic Microwear Analysis of Middle Stone Age Artifacts from White Paintings Rock Shelter, Botswana. *Journal of Field Archaeology* 29(1/2): 155-163.

Dowson, D.

1979 *History of Tribology*. Longman, London.

Driskell, Boyce N.

1986 The Chipped Stone Tool Production /Use Cycle: Its Potential in Activity Analysis of Disturbed Sites. BAR International Series 305.

Driver, Jonathan C.

1993 Early to Late Prehistoric Lithic and Faunal Assemblages, Site DjPp-8, Alberta. *Canadian Journal of Archaeology* 17:43-58.

Dumont, John V.

1983 An Interim Report of the Star Carr Microwear Study. *Oxford Journal of Archaeology* 2: 127-145.

Fedirchuk, Gloria J.

1987 *The Missinglink Site: Kananaskis Country ASA Permit 86-21C*. Prepared for Archaeological Survey of Alberta On behalf of Alberta Transportation. Unpublished Report by FMA Heritage, On File at FMA under 167-86.

Fedirchuk, G.J., E.J. McCullough, L.R. Gorham, W.J. Unfreed, B.J. Kulle, E.M. Gryba, and L.V. Hills

1998 *Historical Resources Impact Assessment Report: Alliance Pipeline Limited Partnership Alliance Pipeline Project, Alberta Permit Number 96-063*. Prepared for TERA Environmental Consultants (Alta.) Ltd. On behalf of Alliance Pipeline Limited Partnership. Unpublished Report by FMA Heritage, On file at FMA under 692/780-HI-1996.

Fenton, Mark M., and John W. Ives

1990 Geoarchaeological Studies of the Beaver River Sandstone, northeastern Alberta. *Geological Society of America* 4:123-135.

Fladmark, Knut R.

1982 An Introduction to the Prehistory of British Columbia. *Canadian Journal of Archaeology* 6: 95-156.

1990 Possible Early Human Occupation of the Queen Charlotte Islands, British Columbia. *Canadian Journal of Archaeology* 14:183-197.

Flannery, Regina

1953 *The Gros Ventres of Montana: Part I Social Life*. The Catholic University of America Anthropological Series No. 15, Catholic University of America Press, Washington D.C.

Fojud, Roman and Michal Kobusiewicz

1982 The Influence of Soluble Salts on the state of Preservation of Flint Surfaces and Wear-Traces. *Studia Praehistorica Belgica* 2: 245-249.

Forbis, Richard G.

1992 The Mesoindian (Archaic) Period in the Northern Plains. *Revista de Arqueologia Americana, Numero 5*: 27-70. Instituto Panamericano de Geografia e Historia.

Foucault, Michel

2002 *The Archaeology of Knowledge*. Routledge, London.

Frison, George C.

1968 A Functional Analysis of Certain Chipped Stone Tools. *American Antiquity* 33:149-155.

1972 Early Period Marginal Cultural Groups in Northern Wyoming. *Plains Anthropologist* 18(62):300-312.

1975 Man's Interaction with Holocene Environments on the Plains. *Quaternary*

Research 5:289-300.

1998 The Northwestern and Northern Plains Archaic. In *Archaeology of the Great Plains*. Edited by W.R. Wood:140-172. University Press of Kansas, Lawrence, Kansas.

Fung, Ka-Iu

1999 *Atlas of Saskatchewan*. Edited by K-I. Fung, B. Barry, and M. Wilson. University of Saskatchewan, Saskatoon.

Gallagher, James P.

1977 Contemporary Stone Tools in Ethiopia: Implications for Archaeology. *Journal of Field Archaeology* 4(4): 407-414.

Giddings Jr., J. L.

1956 A Flint Site in Northernmost Manitoba. *American Antiquity* 21(3): 255-268.

Gonzalez-Urquijo, Jesus E. and Juan J. Ibanez-Estevez

2003 The Quantification of Use-Wear Polish Using Image Analysis. First Results. *Journal of Archaeological Science* 30: 481-489.

Gordon, David

1993 Mousterian Tool Selection, Reduction, and Discard at Ghar, Israel. *Journal of Field Archaeology* 20(2): 205-218.

Gowlett, John A.J.

1982 Procedure and Form in a Lower Palaeolithic Industry: Stoneworking at Kilombe, Kenya. *Studia Praehistorica Belgica* 2:101-110.

Gowlett, John A. J., Jane Hallos, Simon Hounsell, Victoria Brant, and Nicholas C. Debenham

2005 Beeches Pit: Archaeology, Assemblage Dynamics, and Early Fire History of a Middle Pleistocene Site in East Anglia, UK. *Eurasian Prehistory* 3(2): 3-38.

Grabert, Garland F.

1979 Pebble Tool and Time Factoring. *Canadian Journal of Archaeology* 3: 165-176.

Grace, Roger

1989 *Interpreting the Function of Stone Tools*. BAR International Series 474, Oxford.

1990 The Limitations and Applications of Use Wear Analysis. In *The Interpretative Possibilities of Microwear Studies: Proceedings of the International Conference on Lithic Use-Wear Analysis, 15th-17th February 1989 in Uppsala, Sweden*. Edited by B. Graslund: 9-14. Societas Archaeologica Upsaliensis, Uppsala.

1996 Review Article; Use-Wear Analysis: The State of the Art*. *Archaeometry* 38: 209-229.

Grace, R., I.D.G. Graham, and M.H. Newcomer

- 1985 The Quantification of Microwear Polishes. *World Archaeology* 17(1): 112-120.
- Grosman, Leore, Oded Smikt, and Uzy Smilansky
 2008 On the Application of 3-D Scanning Technology for the Documentation and Typology of Lithic Artifacts. *Journal of Archaeological Science* 35:3101-3110.
- Gryba, Eugene M., and Purple Kumai
 2005 Microscopic Use-Wear Studies Plus Microblade Replication Experiments with Raw and Heat Treated Glass Buttes Obsidian. Paper Presented at the 63rd Annual Plains Conference, Edmonton.
- Haley, Shawn
 1996 The Pasika Complex Revisited. In *Early Human Occupation in British Columbia*. Edited by R.L. Carlson and L.D. Bona: 51-64. UBC Press, Vancouver.
- Hardy, Bruce L., and Gary T. Garufi
 1998 Identification of Woodworking on Stone Tools Through Residue and Use-Wear Analyses: Experimental Results. *Journal of Archaeological Science* 25: 177-184.
- Hardy, Bruce L, Marvin Kay, Anthony E. Marks, and Katherine Monigal
 2001 Stone Tool Function at the Paleolithic Sites of Starosele and Buran Kaya III, Crimea: Behavioral Implications. *Proceedings of the National Academy of Sciences of the United States of America* 98(19): 10972-10978.
- Hayden, Brian
 1979 Snap, Shatter, and Superfractures: Use-Wear of Stone Skin Scrapers. In *Lithic Use-Wear Analysis*, edited by B. Hayden, pp.207-229. Academic Press, New York.
 1984 Are Emic Types Relevant to Archaeology? *Ethnohistory* 31(2): 79-92.
 1987 From Chopper to Celt: The Evolution of Resharpener Techniques. *Lithic Technology* 16(2-3): 33-43.
 1997 Observations on the Prehistoric Social and Economic Structure of the North American Plateau. *World Archaeology* 29(2): 242-261.
 2005 *The Pithouses of Keatley Creek*. Second Edition, Archaeology Press, Simon Fraser University, Burnaby, BC.
- Hayden, Brian, Edward Bakewell, and Rob Gargett
 1996a The World's Longest-Lived Corporate Group: Lithic Analysis Reveals Prehistoric Social Organization near Lillooet, British Columbia. *American Antiquity* 61:341-356.
- Hayden, Brian, and Aubrey Cannon
 1984 Interaction Inferences in Archaeology and Learning Frameworks of the Maya. *Journal of Anthropological Archaeology* 3: 325-367.
- Hayden, B., N. Franco, and J. Spafford
 1996b Evaluating Lithic Strategies and Design Criteria. In *Stone Tools: Theoretical*

Insights into Human Prehistory, Edited by G. Odell: 9-46. Plenum Press, New York.

Hayden, Brian, and Margaret Nelson

1981 The use of Chipped lithic Material in the Contemporary Maya Highlands.
American Antiquity 46(4): 885-898.

Hiscock, Peter and Val Attenbrow

2005 Reduction Continuums and Tool Use. In *Lithics 'Down Under': Australian Perspectives on Lithic Reduction, Use and Classification*. Edited by C. Clarkson and L. Lamb: 43-55. BAR International Series 1408, Oxford.

Hiscock, Peter and Chris Clarkson

2005 Measuring Artefact Reduction – An Examination of Kuhn's Geometric Index of Reduction. In *Lithics 'Down Under': Australian Perspectives on Lithic Reduction, Use and Classification*. Edited by C. Clarkson and L. Lamb: 7-20. BAR International Series 1408, Oxford.

Holdaway, Simon

1989 Were There Hafted Projectile Points in the Mousterian? *Journal of Field Archaeology* 16(1): 79-85.

Hurcombe, L.M.

1992 *Use Wear Analysis and Obsidian: Theory, Experiments and Results*. Sheffield Archaeological Monographs 4, J.R. Collis Publications, Department of Archaeology and Prehistory University of Sheffield, Dorchester, England.

Hutchings, Wallace K.

1997 *The Paleoindian Fluted Point: Dar or Spear Armature? The Identification of Paleoindian Delivery Technology Through the Analysis of Lithic Fracture Velocity*. Phd thesis, Department of Archaeology, Simon Fraser University, Burnaby, British Columbia.

Ingold, Timothy

1993 The Temporality of the Landscape. *World Archaeology* 25(2): 152-174.
2004 Culture on the Ground: The World Perceived Through the Feet. *Journal of Material Culture* 9: 315-340.

Ives, John W.

1977 The Excavation of HkPa-4 Birch Mountains, Alberta. In *Archaeological Survey of Alberta; Archaeology in Alberta 1976*, Occasional Paper No.4, edited by J. M. Quigg, pp.37-41. Alberta Culture Historical Resources Division, Edmonton.

Jacobson, Staffan, and Sture Hogmark

2009 Surface Modifications in Tribological Contacts. *Wear* 266: 370-378.

Jeffries, Richard W.

1990 A Technological and Functional Analysis of Middle Archaic Hafted Endscrapers from the Black Earth Site, Saline County, Illinois. *Midcontinental Journal of Archaeology* 15(1): 3-36.

Jensen, Helle J.

1988 Functional Analysis of Prehistoric Flint Tools by High-Power Microscopy: A Review of West European Research. *Journal of World Prehistory* 2(1): 53-88.

Jerardino, Antonieta

2001 Diversity in Mastic-Mounted Stone Adzes and the Use of Mastic in Precolonial South Africa: Evidence from Steenbokfontein Cave. *Antiquity* 75: 859-866.

Johnson, Eldon A.

1984 *Aitkow-3, EgNp-63*. Saskatchewan Archaeological Resource Record. Permit No. 84-11, Saskatchewan Culture and Youth.

1991 Pebble Splitting. *Saskatchewan Archaeological Society Newsletter* 12(5): 79-81.

1993 Lithic Studies – Part Two. *Saskatchewan Archaeological Society Newsletter* 14(4): 74-76.

1994 A Cache of Quartzite Artifacts from the Shore of Lake Diefenbaker. *The Saskatchewan Archaeological Society Newsletter* 15(5): 80-82.

1996 Bipolar?? Forget it! *Saskatchewan Archaeological Society Newsletter* 17(3): 53-54.

1998 Properties and Sources of Some Saskatchewan Lithic Materials of Archaeological Significance. *Saskatchewan Archaeology* 19: 1-45.

1999 Brittle Fracture. *Saskatchewan Archaeological Society Newsletter* 20(4): 82.

Jones, Andrew

2007 *Memory and Material Culture*. Topics in Contemporary Archaeology Series, Series Editor R. Bradley, Cambridge University Press, Cambridge.

Jose-Yacamán, Miguel and Jorge A. Ascencio

2000 Electron Microscopy and its Application to the Study of Archaeological Materials and Art Preservation. In *Modern Analytical Methods in Art and Archaeology* Edited by E. Ciliberto and G. Spoto: 405-443. Wiley-Interscience, New York.

Julig, Patrick J.

1994 *The Cummins Site Complex and Palaeoindian Occupations in the Northwestern Lake Superior Region*. Ontario Heritage Foundation, Ottawa.

Kaminska-Szymczak, Jolanta

2001 Cutting Graminae Tools and ‘Sickle Gloss’ Formation. *Lithic Technology* 27(2): 111-151.

Kasstan, Steven

2004 Lithic Technology at the Below Forks Site, FhNg-25: Strategems of Stone Tool Manufacture. Unpublished M.A. dissertation, Department of Archaeology,

University of Saskatchewan, Saskatoon.

Kay, Marvin

1997 Imprints of Ancient Tool Use at Monte Verde. In *Monte Verde: A Late Pleistocene Settlement in Chile Volume 2: The Archaeological Findings* Edited by T.E. Dillehay: 649-660. Smithsonian Institution Press, Washington D.C.

Kealhofer, Lisa, Robin Torrence, and Richard Fullagar

1999 Integrating Phytoliths within Use-Wear /Residue Studies of Stone Tools. *Journal of Archaeological Science* 26: 527-546.

Keeley, Lawrence H.

1980 *Experimental Determination of Stone Tool Uses: A Microwear Analysis*. The University of Chicago Press, Chicago.

1982. Hafting and Retooling: Effects on the Archaeological Record. *American Antiquity* 47: 798-809.

Klassen, Judith

2004 Paleoenvironmental Interpretation of the Paleosols and Sediments at the Stampede Site (DjOn-26), Cypress Hills, Alberta. *Canadian Journal of Earth Sciences* 41: 741-753.

Kleindienst, Maxine R., Patty Jo Watson

1956 Action Archaeology: The Archaeological Inventory of a Living Community. *Anthropology Tomorrow* 5(1): 75-78.

Knutsson, Kjell

1986 SEM Analysis of Wear Features on Experimental Quartz Tool. *Early Man News* 9-11(1-2): 103-110.

Knutsson, Kjell, and R. Hope

1984 The Application of Acetate Peels in Lithic Usewear Analysis. *Archaeometry* 26(1): 49-61.

Kohl, J.G.

1956 *Kitchi-Gami (Wanderings Round Lake Superior)*. Ross and Haines, Inc., Minneapolis, Minnesota.

Kooyman, Brian P.

2000 *Understanding Stone Tools and Archaeological Sites*. University of Calgary Press, Calgary.

Kuhn, Steven L.

1990 A Geometric Index of Reduction for Unifacial Stone Tools. *Journal of Archaeological Science* 17(5): 583-593.

1992a Blank Form and Reduction as Determinants of Mousterian Scraper Morphology.

- American Antiquity* 57(1): 115-128.
- 1992b On Planning and Curated Technologies in the Middle Paleolithic. *Journal of Anthropological Research* 48(3): 185-214.
- 1996 The Trouble with Ham Steaks: A Reply to Morrow. *American Antiquity* 61(3): 591-595.
- 2004 Evolutionary Perspectives on Technology and Technological Change. *World Archaeology* 36(4): 561-570.
- Kulle, Barbara, FMA Heritage Consultants
- 1996 *Heritage Resources Impact Assessment: Colt Engineering Corporation PanCanadian Petroleum Limited, 1995 Weyburn Unit Projects Permit 95-085*. Prepared for Colt Engineering Corporation on Behalf of PanCanadian Petroleum Lmtd. Unpublished Report by FMA Heritage, On File at FMA under 593-HI-1995.
- 1997 *Historical Resources Mitigation: Cardinal river Coals Ltd. Cheviot Mine Project, Sites FfQh-27 and FfQh-32*. Permit 97-115, Unpublished Report, Prepared for Cardinal River Coals Ltd. FMA Heritage Consultants, Fedirchuk McCullough & Associates Ltd. (837-MI-1997 in their library, on file).
- Larson, Mary Lou, and Marcel Kornfeld
- 1997 Chipped Stone Nodules: Theory, Method, and Examples. *Lithic Technology* 22(1): 4-18.
- Lemorini, Cristina, Mary C. Stiner, Avi Gopher, Ron Shimelmitz, and Ran Barkai
- 2006 Use-Wear Analysis of an Amudian Laminar Assemblage from the Acheuleo-Yabrudian of Qesem Cave, Isreal. *Journal of Archaeological Science* 33: 921-934.
- Levitt, Jeff
- 1979 A Review of Experimental Traceological Research in the USSR. In *Lithic Use-Wear Analysis*, edited by B. Hayden, pp.27-38.
- Leyden, Jeremy J.,
- 2004 *Paleoecology of Southern Saskatchewan Bison: Changes in Diet and Environment as Inferred Through Stable Isotope Analysis of Bone Collagen*. MA Thesis, University of Saskatchewan, Unpublished
- Leyden, Jeremy J., Leonard I. Wassenaar, Keith A. Hobson, and Ernest G. Walker
- 2006 Stable Hydrogen Isotopes of Bison Bone Collagen as a Proxy for Holocene Climate on the Northern Great Plains. *Palaeogeography, Palaeoclimatology, Palaeoecology* 239: 87-99
- Linnamae, Urve
- 1998 *The Heron Eden Site in the Northern Plains Paleoindian World*. Paper presented at Canadian Archaeological Association 31st Annual Conference, Victoria BC.
- Linnamae, Urve, and Eldon Johnson
- 1999 An Analysis of the Lithic Collection from the Heron Eden Site: A Cody Complex

Manifestation in Saskatchewan. Saskatoon Archaeological Society, Saskatoon, Saskatchewan.

Long, D.F.G., P.J. Julig, and R.G.V. Hancock

2002 Characterization of Sheguiandah Quartzite and other Potential Sources of Quartzarenite Artifacts in the Great Lakes Region. In *The Sheguiandah Site: Archaeological, Geological and Paleobotanical Studies at a Paleoindian site on Manitoulin Island, Ontario*. Edited by P.J. Julig: 265-296. Canadian Museum of Civilization, Ottawa.

MacDonald, George F., and David Sanger

1968 Some Aspects of Microscope Analysis and Photomicrography of Lithic Artifacts. *American Antiquity* 33(2): 237-240.

Malasiuk, Jordyce

2001 Summary of the Archaeological Recoveries Made During the Churchill River Diversion Archaeological Project 1999. *Manitoba Archaeological Journal* 11(1-2): 1-153.

Mandal, Stephen, Aidan O'Sullivan, Emmet Byrnes, David Weddle, and Jimmy Weddle

2000 Archaeological Experiments in the Production of Stone Axeheads. In *Lithics in Action* Edited by E.A. Walker, F. Wenban-Smith, and F. Healy: 116-123. Oxbow Books, Oxford England.

Mansur, Maria Estela

1982 Microwear Analysis of Natural and Use Striations: New Clues to the Mechanisms of Striation Formation. *Studia Praehistorica Belgica* 2: 213-233.

Martindale, Andrew, and Irene Jurakic

2006 Identifying Expedient Glass Tools from a Post-Contact Tsimshian Village using Low Power (10-100x) Magnification. *Journal of Archaeological Science* 33: 414-427.

Mathieu, James R., and Daniel A. Meyer

1997 Comparing Axe Heads of Stone, Bronze, and Steel: Studies in Experimental Archaeology. *Journal of Field Archaeology* 24(3): 333-351.

McBrearty, Sally, Laura Bishop, Thomas Plummer, Robert Dewar, and Nicholas Conard

1998 Tools Underfoot: Human Trampling as an Agent of Lithic Artifact Edge Modification. *American Antiquity* 63(1): 108-129.

McCullough, Edward J.

1981 *Historical Resources Impact Assessment Lutz Properties Ltd. Park Royal Estates Subdivision SW-9-74-5 W6M ASA Permit No. 81-166*. Prepared for Elbe, Lock, Walls and Associates Inc. Unpublished Report by FMA Heritage, On File at FMA under 41-81.

- 1982 Prehistoric Cultural Dynamics of the Lac La Biche Region. In *Archaeological Survey of Alberta Occasional Paper 18*. Alberta Cultural Historical Resources Division, Edmonton.
- McCullough, Fedirchuk and M.C. Wilson
1982 *A Prehistoric Settlement-Subsistence Model for Northeastern Alberta: Canstar Oil Sands Ltd. Bituminous Sands Leases 33, 92, and 95: A Preliminary Statement*. Prepared for Canstar Oil Sands Ltd. Prepared by Fedirchuk McCullough & Associates Ltd. Unpublished manuscript, on file at the University of Calgary Library.
- McGovern, Patrick E.
1995 Science in Archaeology: A Review. *American Journal of Archaeology* 99: 79-83.
- Merleau-Ponty,
2002 *Phenomenology of Perception*. Translated by C. Smith. Routledge, London.
- Meyer, Dan and Jason Roe
2008 *Excavations at the Upper Lovett Campsite (FgQf-16) from 2005 to 2006*. Poster at the 2008 Annual Conference of the Archaeological Society of Alberta, Medicine Hat, May 2-4, 2008.
- Meyer, David
1977 *Pre-Dorset Settlements at the Seahorse Gully Site*. National Museum of Canada, Ottawa.
- Meyer, David and Dale R. Russell
2007 Aboriginal Peoples from the Ice Age to 1870. In *Saskatchewan: Geographic Perspectives*. Edited by B.D. Thraves et al.:101-118. Canadian Plains Research Center, Regina.
- Moore, Mark W.
2004 The Tula Adze: Manufacture and Purpose. *Antiquity* 78(299): 61-73.
- Morin, Jesse
2004 Cutting Edges and Salmon Skin: Variation in Salmon Processing Technology on the Northwest Coast. *Canadian Journal of Archaeology* 28: 281-318.
- Morrow, Toby A.
1996 Bigger is Better: Comments on Kuhn's Formal Approach to Mobile Tool Kits. *American Antiquity* 61(3): 581-590.
- Moss, Emily H.
1983 *The Functional Analysis of Flint Implements. Pincevent and Pont d'Ambon: Two Case Studies from the French Final Paleolithic*. Oxford: British Archaeological Report International Series 177.

Moss, Emily H., and Mark H. Newcomer

1982 Reconstruction of Tool Use at Pincevent: Microwear and Experiments. *Studia Praehistorica Belgica* 2: 289-312.

Neal, Barb

2006 *Precontact Utilization of Sandhill Environments During the Pelican Lake and Besant Phases*. Masters thesis, Unpublished, Department of Archaeology, University of Saskatchewan, Saskatoon, Saskatchewan.

Nissen, Karen and Margaret Dittmore

1974a *Ethnological Results of the Point Barrow Expedition*. Bureau of American Ethnology, 9th Annual Report. Government Printer, Washington, D.C.

1974b Ethnographic Data and Wear Pattern Analysis: A Study of Socketed Eskimo Scrapers. *Tebiwa* 17: 67-88.

Odell, George H.

1981 The Mechanics of Use-Breakage of Stone-Tools: Some Testable Hypotheses. *Journal of Field Archaeology* 8(2): 197-209.

1985 Small Sites Archaeology and Use-Wear on Surface-Collected Artifacts. *Midcontinental Journal of Archaeology* 10: 21-48.

1988 Addressing Prehistoric Hunting Practices Through Stone Tool Analysis. *American Anthropologist* 90(2): 335-356.

1993 Fitting Analytical Techniques to Prehistoric Problems with Lithic Data. *Archaeological Papers of the American Anthropological Association* 4(1): 107-125.

1994 Prehistoric Hafting and Mobility in the North American Midcontinent: Examples from Illinois. *Journal of Anthropological Archaeology* 13: 51-73.

2001 Stone Tool Research at the End of the Millennium: Classification, Function, and Behavior. *Journal of Archaeological Research* 9(1): 45-100.

2003 *Lithic Analysis*. Springer, New York.

Odell, George H., and Frank Cowan

1986 Experiments with Spears and Arrows on Animal Targets. *Journal of Field Archaeology* 13(2): 195-212.

Odell, George H., and Frieda Odell-Vereecken

1980 Verifying the Reliability of Lithic Use-Wear Assessments by 'Blind Tests': The Low-Power Approach. *Journal of Field Archaeology* 7(1): 87-120.

Oetelaar, Gerald A.

1995 *Archaeological Research and Excavations at the Strathcona Site (FjPi-29) –1986 through 1990*. Report Prepared for Archaeological Survey of Alberta, Provincial Museum of Alberta, Edmonton.

2004 Stone Circles, Social Organization, and Special Places: Forbis' Skepticism Revisited. In *Archaeology on the Edge: New Perspectives from the Northern Plains*. Edited by B. Kooyman and J. Kelley: 125-155. Canadian Archaeological Association Occasional Paper No. 4, University of Calgary Press, Calgary, Alberta.

Owen, Linda

1982 An Analysis of Experimental Breaks on Flint Blades and Flakes. *Studia Praehistorica Belgica* 2: 77-87.

Pappalardo, L., F.P. Romano, S. Garraffo, J. De Sanoit, C. Marchetta, and G. Pappalardo
2003 The Improved LNS PIXE-ALPHA Portable System: Archaeometric Applications. *Archaeometry* 45(2): 333-339.

Pawlik, Alfred F.

2000 Identification of Hafting Traces and Residues by Scanning Electron Microscopy and Energy-Dispersive Analysis of X-Rays. In *Lithics in Action: Papers from the Conference, Lithic Studies in the Year 2000*. Edited by E.A. Walker, F. Wenban-Smith, and F. Healy: 169-179. Oxbow Books, Oxford.

Pelcin, Andrew

1997 The Effect of Indentor Type on Flake Attributes: Evidence from a Controlled Experiment. *Journal of Archaeological Science* 24(7): 13-621.

Perles, Catherine

1982 Les "Outils D'Orville": Des Nucleus a Lamelles. *Studia Praehistorica Belgica* 2: 129-148.

Plew, Mark G., James C. Woods

1985 Observation of Edge Damage and Technological Effects on Pressure-Flaked Stone Tools. In *Stone Tool Analysis: Essays in Honor of Don E. Crabtree*, Edited by M.G. Plew, J.C. Woods, and M.G. Pavesic: 211-227. University of New Mexico, Albuquerque.

Plisson, Hugues

1983 An Application of Casting Techniques for Observing and Recording Microwear. *Lithic Technology* 12: 17-21.

Polio, Cara

2009 Cut Mark Analysis of Protohistoric Bison Remains from EfPm-27 Utilizing the Scanning Electron Microscope. Unpublished Masters Thesis, Depart of Archaeology, University of Saskatchewan, Saskatoon.

Pollard, A. Mark, and Carl Heron

2008 *Archaeological Chemistry*. 2nd Edition. RSC Publishing, Cambridge.

Pye, David

1982 The Six Requirements for Design. In *Material Culture Studies in America* Edited by T.H. Schlereth: 153-161. The American Association for State and Local History, Nashville, Tennessee.

Pyszczyk, Heinz W.

2003 Aboriginal Bows and Arrows and other Weapons in Alberta: The Last 2,000 Years, or Longer? *Archaeology in Alberta: A View from the New Millennium*. Edited by J.W. Brink, and J.F. Dormaar: 46-71. Archaeological Society of Alberta, Medicine Hat, Alberta.

Quigg, J. Michael

1984 A 4700 Year-Old Tool Assemblage from East-Central Alberta. *Plains Anthropologist* 29(104): 151-159.

Rahemtulla, Farid

2003 The Use of Large Terrestrial mammal Bone on the Northwest Coast. In *Archaeology of Coastal British Columbia; Essays in Honour of Professor Philip M. Hobler*. Edited by R.L. Carlson: 61-64. Archaeology Press, Simon Fraser University, Burnaby, B.C.

Rast, Tim

2008 Ramah Chert: A Qualitative Discussion of its Flaking Properties. *North Atlantic Archaeology* 1: 157-162.

Rees, D., G.G. Wilkinson, R. Grace, and C.R. Orton

1991 An Investigation of the Fractal Properties of Flint Microwear Images. *Journal of Archaeological Science* 18: 629-640.

Reichelt, Rudolf

2007 Scanning Electron Microscopy. In *Science of Microscopy Volume 1* Edited by P.W. Hawkes and J.C.H. Spence: 133-272. Springer, New York.

Reid, J. Jefferson, Michael B. Schiffer, and William L. Rathje

1975 Behavioral Archaeology: Four Strategies. *American Anthropologist* 77(4): 864-869.

Ritchie, J.C.

1976 The Late-Quaternary Vegetation History of the Western Interior of Canada. *Canadian Journal of Botany* 54: 1793-1818.

Robertson, Elizabeth C.

2006 *Late Quaternary Landform Development, Paleoenvironmental Reconstruction and Archaeological Site Formation in the Cypress Hills of Southeastern Alberta*. PHD thesis, University of Calgary, Department of Archaeology.

Roe, Jason

2009 *Making and Understanding Embarras Bipoints: The Replication and Operational Sequencing of a Newly Defined Stone Tool from the Eastern Slopes of Alberta*. University of Saskatchewan, Department of Archaeology Masters Thesis.

Root, Matthew J.

- 2004 Technological Analysis of Flake Debris and the Limitations of Size-Grade Techniques. In *Aggregate Analysis in Chipped Stone*. Edited by C. T. Hall and M. L. Larson: 21-44. The University of Utah Press, Salt Lake City, Utah.
- Rosen, Steven A.
1983 Tabular Scraper Trade: A Model of Material Cultural Dispersion. *Bulletin of the American Schools of Oriental Research* 249: 79-86.
- Rots, Veerle, and Pierre M. Vermeersch
2000 Experimental Characterization of Hafting Traces and their Recognition in Archaeological Assemblages. In *Lithics in Action: Papers from the Conference, Lithic Studies in the Year 2000*. Edited by E.A. Walker, F. Wenban-Smith, and F. Healy: 156-168. Oxbow Books, Oxford.
- Rots, Veerle, and B.S. Williamson
2004 Microwear and Residue Analysis in Perspective: The Contribution of Ethnoarchaeological Evidence. *Journal of Archaeological Science* 31: 1287-1299.
- Rousseau, Michael Keith
2004 Old Cuts and Scrapes: Composite Chipped Stone Knives on the Canadian Plateau. *Canadian Journal of Archaeology* 28(1): 1-31.
- Rousseau, Michael K., Lisa Seip, Paul Ewonus, and Simon Kaltenrieder
2003 Port Hammond Revisited. In *Archaeology of Coastal British Columbia; Essays in Honour of Professor Philip M. Hobler*. Edited by R.L. Carlson: 39-44. Archaeology Press, Simon Fraser University, Burnaby, British Columbia.
- Salls, Roy A.
1985 The Scraper Plane: A Functional Interpretation. *Journal of Field Archaeology* 12(1): 99-106.
- Samuels, L.E., E.D. Doyle, and D.M. Turley
1981 Sliding Wear Mechanisms. In *Fundamentals of Friction and Wear of Materials: Papers Presented at the 1980 ASM Materials Science Seminar, 4-5 October 1980, Pittsburg, Pennsylvania*. Edited by D. A. Rigney: 13-41. American Society for Metals, Metals Park, Ohio.
- Sands, Rob
1997 Prehistoric Woodworking: The Analysis and Interpretation of Bronze and Iron Age Toolmarks. Institute of Archaeology, University College London, London.
- Sanger, David
1967 Prehistory of the Pacific Northwest Plateau as Seen from the Interior of British Columbia. *American Antiquity* 32(2): 186-197.
1996 Gilman Falls Site: Implications for the Early and Middle Archaic of the Maritime Peninsula. *Journal of Canadian Archaeology* 20: 7-28.

2008 Discerning Regional Variation: The Terminal Archaic Period in the Quoddy Region of the Maritime Peninsula. *Canadian Journal of Archaeology* 32:1-42.

Sanger, David, and Bonnie Newsom

2000 Middle Archaic in the Lower Piscataquis River, and its Relationship to the Laurentian Tradition in Central Maine. *The Maine Archaeological Society Bulletin* 40(1): 1-22.

Sauchyn, M.A. and D.J. Sauchyn

1991 A Continuous Record of Holocene Pollen from Harris Lake, Southwestern Saskatchewan, Canada. *Palaeogeography, Palaeoclimatology, Palaeoecology* 88:13-23.

Schaepe, David M.

2003 Validating the Maurer House. In *Archaeology of Coastal British Columbia; Essays in Honour of Professor Philip M. Hobler*. Edited by R.L. Carlson: 113-152. Archaeology Press, Simon Fraser University, Burnaby, British Columbia.

Schiffer, Michael B.

1976 *Behavioral Archaeology*. Academic Press, New York.

Schlebecker, John T.

1982 The Use of Objects in Historical Research. In *Material Culture Studies in America* Edited by T.H. Schlereth: 93-100. The American Association for State and Local History, Nashville, Tennessee.

Schweger, C.E.

1987 A Critical Appraisal of the Altithermal and its Role in Archaeology. In *Man and the Mid-Holocene Climatic Optimum*. Edited by N.A. McKinnon and G.S.L. Stuart: 371-377. Proceedings of the 17th Annual Chacmool Conference, The Archaeological Association of the University of Calgary, Calgary, Alberta.

Shea, John J.

1992 Lithic Microwear Analysis in Archeology. *Evolutionary Anthropology* 1(4): 143-150.

Shea, John J., and Joel D. Klenck

1993 An Experimental Investigation of the Effects of Trampling on the Results of Lithic Microwear Analysis. *Journal of Archaeological Science* 20: 175-194.

Shelley, Cameron

1999 Multiple Analogies in Archaeology. *Philosophy of Science* 66(4): 579-605.

Shelley, Phillip H.

1990 Variation in Lithic Assemblages: An Experiment. *Journal of Field Archaeology* 17(2): 187-193.

Shott, Michael J.

1996 An Exegesis of the Curation Concept. *Journal of Anthropological Research* 52: 259-280.

1998 Status and Role of Formation Theory in Contemporary Archaeological Practice. *Journal of Archaeological Research* 6(4): 299-329.

2002 Weibull Estimation on Use-Life Distribution in Experimental Spear-Point Data. *Lithic Technology* 27(2): 93-109.

Sillitoe, Paul and Karen Hardy

2003 Living Lithics: Ethnoarchaeology in Highland Papua New Guinea. *Antiquity* 77(297): 555-566.

Skriver, Claus

2000 Use-Wear Analysis of Flint Artefacts used for Cutting Roasted Meat and Fresh Hide: A Methodological Problem? In *Lithics in Action* Edited by E.A. Walker, F. Wenban-Smith, and F. Healy: 152-155. Oxbow Books, Oxford England.

Smit, Z., G. Grime, S. Petru, and I. Rajita

1999 Microdistribution and Composition of Usewear Polish on Prehistoric Stone Tools. *Nuclear Instruments and Methods in Physics Research B*. 150: 565-570.

Smit, Z., S. Petru, G. Grime, T. Vidmar, M. Budnar, B. Zorko, and M. Ravnkar

1998 Usewear-Induced Deposition on Prehistoric Flint Tools. *Nuclear Instruments and Methods in Physics Research B*. 140: 209-216.

Steinbring, Jack

1980 *An Introduction to Archaeology on the Winnipeg River*. Department of Culture, Heritage and Recreation, Papers in Manitoba Archaeology, Winnipeg.

Stemp, W. James, and Michael Stemp

2001 UBM Laser Profilometry and Lithic Use-Wear Analysis: A Variable Length Scale Investigation of Surface Topography. *Journal of Archaeological Science* 28: 81-88.

2003 Documenting Stages of Polish Development on Experimental Stone Tools: Surface Characterization by Fractal Geometry Using UBM Laser Profilometry. *Journal of Archaeological Science* 30: 287-296.

Steuber, Karin

2008 *The Consort pebble Chert Quarry Site (EkOr-8) and the Role of Chert Pebbles in Pre-Contact Sites on the Canadian Plains*. University of Saskatchewan, Department of Archaeology Masters Thesis.

Stevenson, Tom

1992 Chipped Stone Tools from EgNq-18. *The Saskatchewan Archaeological Society Newsletter* 13(1): 3-4.

1993 Lake Diefenbaker Site Survey Update. *The Saskatchewan Archaeological Society*

- Newsletter* 14(6): 109-112.
1998 A Pestle Cache from EgNq-15/16, Lake Diefenbaker. *The Saskatchewan Archaeological Society Newsletter* 19(1): 4-7.
- Stout, Dietrich
2002 Skill and Cognition in Stone Tool Production: An Ethnographic Case Study from Irian Jaya. *Current Anthropology* 43(5): 693-722.
- Suh, Nam P.
1981 Update on the Delamination Theory of Wear. In *Fundamentals of Friction and Wear of Materials: Papers Presented at the 1980 ASM Materials Science Seminar, 4-5 October 1980, Pittsburg, Pennsylvania*. Edited by D. A. Rigney: 44-71. American Society for Metals, Metals Park, Ohio.
- Tilley, Christopher
2004 *The Materiality of Stone: Explorations in Landscape Phenomenology*. Berg Press, Oxford.
- Trigger, Bruce G.
2007 *A History of Archaeological Thought*. Cambridge University Press, Cambridge.
- Tringham, Ruth, Glenn Cooper, George Odell, Barbara Voytek, and Anne Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. *Journal of Field Archaeology* 1(1/2): 171-196.
- Unfreed, Wendy J.
1997 *Preliminary Historical Resources Impact Assessment, Husky Oil Ltd. Moose Mountain Pipeline Project (NW-22-23-7-W5M to NW-36-24-6-W5M) Permit Number 96-87*. Unpublished Report prepared for GAIA Environmental Planning and Communication, Calgary, On Behalf of Husky Oil Ltd., Written by FMA Heritage, On File at FMA Heritage under 714-HI-1996a.
- Unger-Hamilton, Romana
1984 The Formation of Use-Wear Polish on Flint: Beyond the 'Deposit versus Abrasion' Controversy. *Journal of Archaeological Science* 11: 91-98.
- Vance, R.E., A. Beaudoin, and B. Luckman
1995 The Paleoecological Record of 6 ka BP Climate in the Canadian Prairie Provinces. *Geographie Physique et Quaternaire* 49:81-98.
- Vaughan, Patrick C.
1985 *Use-Wear Analysis of Flaked Stone Tools*. The University of Arizona Press, Tucson.
- Vivian, Brian C., Dan Meyer, Jason Roe, and Janet Blakey
2008 *2007 Historical Resources Excavations at the Stampede Site (DjOn-26) Final*

Report (Permit 2007-382). Unpublished archaeological consultant manuscript.
Prepared for Archaeology and History Section Historic Resources Management
Branch of Alberta Tourism, Parks, Recreation and Culture.

Walker, Ernest G.

1992 *The Gowen Sites: Cultural Responses to Climatic Warming on the Northern Plains (7500-5000 B.P.)*. Canadian Museum of Civilization, Hull, Quebec.

Walker, P.L. and J.C. Long

1977 An experimental Study of the Morphological Characteristics of Tool Marks.
American Antiquity 42(4): 605-616.

Webster, Sean M.

2009 *A Re-Evaluation of the McKean Series on the Northern Plains*. Occasional Papers
in Archaeology No.1, Saskatchewan Archaeology Society and Department of
Archaeology and Anthropology, University of Saskatchewan, Saskatoon.

Weedman, Kathryn J.

2002 On the Spur of the Moment: Effects of Age and Experience on Hafted Stone
Scraper Morphology. *American Antiquity* 67:731-744.

2006 An Ethnoarchaeological Study of Hafting and Stone Tool Diversity among the
Gamo of Ethiopia. *Journal of Archaeological Method and Theory* 13(3): 189-238.

White, J. Peter

1968 Ston Nap Bilong Tumbuna: The Living Stone Age in New Guinea. In *La
Prehistoire*, Edited by R. Vaufray: 511-516. Editions du Centre National de la
Recherche Scientifique, Paris.

White, J.Peter, and D.H. Thomas

1972 What Mean These Stones? Ethno-Taxonomic Models and Archaeological
Interpretations in the New Guinea Highlands. In *Models in Archaeology* Edited by
D.L. Clarke: 275-308. Methuen and Co. Ltd, London.

Whittaker, J.C.

1994 *Flintknapping: Making and Understanding Stone Tools*. University of Texas,
Austin, Texas.

Wilmsen, Edwin N.

1968 Functional Analysis of Flaked Stone Artifacts. *American Antiquity* 33: 151-161.

Wilson, Lyn, A. Mark Pollard, Allan J. Hall, and Andrew S. Wilson

2006 Assessing the Influence of Agrochemicals on the Rate of Copper Corrosion in the
Vadose Zone of Arable Land –Part 3: Geochemical Modeling. *Conservation and
Management of Archaeological Sites* 7:241-260.

Winham, Peter, David Walter, and Robert C. Mainfort

- 1996 Archaeology of the Northwestern Plains. In *Archeological and Bioarcheological Resources of the Northern Plains* Edited by G.C. Frison and R.C. Mainfort: 8-40. Arkansas Archaeological Survey Research Series No. 47, Fayetteville, Arkansas.
- Wobst, H. Martin
1999 Style in Archaeology or Archaeologists in Style. In *Material Meanings: Critical Approaches to the Interpretation of Material Culture* Edited by E.S. Chilton: 103-117. University of Utah Press, Salt Lake City Utah.
- Wright, Jim V.
2006 *A History of the Native People of Canada: Volume I (10,000-1,000 BC)*. Mercury Series Archaeological Paper 152, Canadian Museum of Civilization, Gatineau, Quebec.
- Wylie, Alison
1985 The Reaction Against Analogy. In *Advances in Archaeological Method and Theory: Volume 8*, edited by M.B. Schiffer, pp.63-111. Academic Press, Orlando.
- Yansa, Catherine H.
1998 Holocene Paleovegetation and Paleohydrology of a Prairie Pothole in Southern Saskatchewan, Canada. *Journal of Paleolimnology* 19: 429-441
2007 Lake Records of Northern Plains Paleoindian and Early Archaic Environments; The "Park Oasis" Hypothesis. *Plains Anthropologist* 52(201): 109-144
- Young, Donald, and Douglas B. Bamforth
1990 On the Macroscopic Identification of Used Flakes. *American Antiquity* 55(2): 403-409.
- Zurburg, Suzanne Caroline
1991 *The Norby Site: A Mummy Cave Complex Bison Kill on the Northern Plains*. Department of Archaeology, University of Saskatchewan M.A. Thesis, Saskatoon.

Appendix A

Usewear Definitions

A-1.0 Introduction

Regardless of shape, a stone tool will develop wear (Kay 1997). Wear traces are diagnostic to particular tasks and the working of particular materials (White 1968:514; Keeley 1980). Objectivity in recording wear has been problematic, as it tends to be more qualitative than quantitative in nature and not all tools develop wear equally; some have claimed that usewear research has been “struggling to produce standard procedures for observation and description” (Plisson 1983:1614). This is not the case, as this appendix will show.

The starting point to any discussion on usewear is to identify the terminology that one is using. Therefore, this section provides definitions of the four main types of wear traces: polish, striations, microchips, and rounding. These four types include both loss and addition to a stone’s surface. Other authors have utilized a similar four-point scheme (Shea 1992:143-4); although, Kooyman (2000) had combined rounding with microchipping in his classification. Adams (1988:310) also differed in terminology with her scheme: abrasive, adhesive, fatigue and tribochemical.

The four main types of wear are discussed in this appendix. Each type (polish, striations, microchipping, and rounding) is defined according to the literature and related to what these wears signify. Caveats within usewear research are discussed with reference to how one differentiates unintentional from intentional trauma. To conclude the section, a further caveat is discussed: differences in lithic raw material. This final discussion is important for it describes the difficulties and prospects in studying quartzite for evidence of wear traces. Below are descriptions of some important activities that tools are used in and how this relates to tool wear; in addition, projectile and hafting wear. Tool motion is moreover briefly discussed with emphasis on what can be inferred from the wear.

Butchering

Butchering produces three diagnostic types of wear (Kay 1997). First are individual polishes that intersect one another. These polishes are “oriented transversely to the cutting edge” (Kay 1997:653). Second are polishes located adjacent to the cutting edge and running parallel to one another. Third are abrasive polishes located near the tool’s working edge.

Cutting

Cutting is a slicing or sawing motion where a tool’s working edge penetrates a material. Considerable force is not always needed for the sharpness of an edge is usually enough to facilitate the desired cutting action. Different materials also have different affects on a stone tool when cut. For instance cutting hide produces more wear on a tool’s edge than cutting meat (Hayden et al. 1996b:19). *Sawing* refers to the tool being pushed and pulled in two directions to cut a material, but when the tool is used to cut in only one direction it is termed *slicing*. Sawing and slicing actions can chip both faces of a tool’s edge (Odell and Vereecken 1980:98). If the tool was used in only one direction then the chips will be oriented (slanted) in that one direction; striations will moreover be orientated in this direction. The chips on opposing faces of the edge are not parallel to each other. Striations sometimes develop near or parallel to the tool’s edge. Rounding can also occur, and is commonly restricted to high-relief /projections.

Scraping

A tool’s edge is orientated in a vertical line when cutting, while scraping has that edge placed in a horizontal line. This edge is pulled toward the user when scraping. This action creates wear across a broader area of the tool’s working surface in contrast to slicing (Salls 1985:103). Scraping exerts force on the hafted area due to the strain placed on the horizontally oriented tool (Rots and Vermeersch 2000:165). The working edge of a scraping tool additionally produces unifacial scarring on the tool’s working edge (Odell and Vereecken 1980:99). Striations occur on the face opposite to the face with microchips, and these striations run perpendicular to the edge. Similar to cutting actions, abrasion is commonly found on areas of high-relief and projections on the edge.

When the tool is pushed away from the user, it is said to be *planing*. Wear from a tool used to plane a material is similar to a tool used to scrape, which is a pulling action (Odell and Vereecken 1980:99). However, abrasion wear is more common in tools used to plane (Salls 1985:103). Abrasive wear forms on the surface that made direct contact with the worked material. Abrasion is also very common in tools used to *adze*. Adzing is a high-pressure activating that pushes a tool across a material (Rots and Vermeersch 2000:165). This is described as a transverse motion that produces microchips on only one face of the working edge (Odell and Vereecken 1980:100).

Chopping

Chopping results in bifacially placed edge damage that is symmetrical when viewed (Odell and Vereecken 1980:99). A tool's edge impacts the surface of a worked material similar to that of a projectile point. It sometimes leaves that material with a twist to dislodge said tool. This impact results in damage that can be similar to that of a used projectile point. Microchips are common along the edges of tools used for chopping. These chips have well defined terminations and are commonly hinged or stepped terminated. Microchips such as these are additionally formed from *wedging* actions. Striations are also common. These striations are orientated obliquely to the edge.

Similar to chopping is pounding. Pounding is when a tool is used like a modern hammer. The working surface is usually flat and not an edge. Pits and cracks on this surface characterize the wear. (Odell and Vereecken 1980:100).

Graving /Boring

Graving is defined as employing a tool only on its point or tip and not on its sides. Motions can be either longitudinal or /and transverse (Odell and Vereecken 1980:99). *Boring*, in contrast, is when pressure is applied in a downward manner on a tool, while providing a lateral twist (Odell and Vereecken 1980:99). Grinding or polishing of a surface is also common when graving or boring. Usewear also commonly forms on the tool's surface rather than on its edge. Abrading wear is common, both on the tip and hafted areas of the tool.

Projectile Points

A shape's design must consider its ability to penetrate. Any used object needs to penetrate something else, whether it is a liquid, solid, or gas. The resistance that the used object encountered is gauged and reflected to different degrees in that object's form and design (Pye 1982:158). The failure of an object to penetrate results in wears. Impact fluting is one signifier of projectile failure (Holdaway 1989:80). Impact flutes are flakes removed from the face of a point, near the tip, or a burin-like spalls struck from the adjacent edges. Flaking at the proximal end where the tool was hafted is also common, along with crushing and sometimes a transverse snap. Such snaps are often found at non-habitation sites as this occurs during use, while away from the camp on the hunt. Broken tools are discarded when broken and unlikely to be returned to the campsite. However the proximal halves can be altered into other tool forms or re-flaked into a new point; for instance recent studies of scrapers from a Middle Paleolithic site (Starosele and Buran Kaya III from the Crimea) show they were originally used as projectile points (Hardy et al. 2001:10973). Further, while there are definite preconditions for the function of a projectile in its morphology, this morphology does not have to be formal. Odell (1988) demonstrated how artifacts that were not shaped like traditional projectile points were additionally used to tip projectiles. This was demonstrated through looking at the types of diagnostic impact damages that occur on stone projectiles. These damages were then looked for in other artifact forms and found. Odell and Cowan (1986) discussed how stone projectile points do not have to be well formed, but instead flakes with simple modifications could be used to tip points. They also cite Clark's 1977 argument that in many cases traditional and prehistoric hunters would not wish to retrieve their projectile points, adding weight to Odell and Cowan's remark that little shaping was required in creating a projectile point.

Breakage patterns of projectile points have also received attention. Any breakage of a tool can be considered *fatigue wear* and is the result of a "mechanical failure of the tool as the tensile strength of the raw material is exceeded by forces of impact" (Dockall 1997:322). This is the same principle for the wear that occurred when a projectile point struck a target (Odell and Cowan 1986; Hutchings 1997). Upon striking, and logically speaking, the point either breaks or is subject to a form of abrasive damage. Such

abrasive damage usually consists of striations that run lengthwise from the point's tip. The lengthwise orientation of a striation, among other idiosyncratic attributes, set projectile point usewear apart from tools of different functions. Polishes can additionally form on a projectile point's tip. Polishes are orientated in the same direction as the striations as they are created at the same time and by the same action (Kay 1997:653). Additionally, the study of such point usewear provides suggestions on how the points were shot and is informative in comparing one technology against another. Also important is the observation that in experiments, the "damage to the tip was more frequent than damage to the base, and the types of damage occurring on either end were similar to one another" (Odell and Cowan 1986:208). As a caveat, Odell (1981) discussed how chopper and projectile point wear is similar since it is created through their impact with a contact material. Bending fractures likewise occur with chopping as the tool can become stuck in the material and needs to be twisted out.

Hafting

An article by Rots and Vermeersch (2000:157) is one of the rare but increasingly popular topics of looking at wear traces from hafting. As the authors lament, this has historically been a subject with some reference but with no prior systematic study. These previous studies discussed this issue in only general terms, however Keeley's work (1982) is one of the exceptions. In 1987 D. Stordeur orchestrated a conference where the dialogue on hafting traces began and initiated some of the first experiments in hafting. For Rots and Vermeersch (2000), their hafting experiments looked specifically at adzing tools used to work wood and earth. Their research straddled two central problems as applied to the archaeological assemblage from an Early Neolithic site in Belgium, Vaux-et-Borset. These two problems were: how do usewear traces differ from hafting traces, and "in what way [does] action and worked material influence the production of hafting traces" (Rots and Vermeersch 2000:156).

Evidence for how artifacts were hafted or held has historically been supported solely through ethnographic analogies (Odell 1994:60). Studies published in the 1980's and 90's moved away from the sole reliance upon ethnographic analogies and began using methods found in other usewear projects. This increasing interest and change in

methodology was partially brought on by research into projectile points –discussed above. This research also brought out two main questions: how the tool was hafted, and how it can break in that haft, most specifically being related to projectiles. French researchers Collin and Jardon-Giner (1993 In Odell 2001:53) is an example where 300 hafted hide scrapers were analyzed, but only trends and no definite diagnostics were found. French researchers, Owen and Unrath (1989 In Odell 2001:53) provide another example where they conducted experiments where the goal was to distinguish a working edge from the hafted edge.

Unhafted tools (*prehended* tools) too display use damage, but it has been difficult to note such wear and the published results have been mixed (Odell 1981:207; Vaughan 1985:39; Odell 2001:53). This damage is from the force of the holder's hand, where the grip wraps around the tool's edges (Odell and Odell-Vereecken 1980:103). The hand's force is directed in only one way as it is being held, although the tool's position in the hand can be easily shifted. Small flakes, microchips, are removed from the edge opposite to the grip, as the pressure of the grip is applied toward the edge of that tool; these chips form on only one edge (Odell 1981:207). Thin edges develop more wear than thicker edges (Odell 1981:207). These microchips are characterized by their feather terminations and are similar to usewear caused by cutting meat, as this is what the hand truly is (Odell and Odell-Vereecken 1980:103). Although, the difference between the usewear of cutting meat and holding a tool is that usewear derived from prehension is far more limited, although it can be found on a larger area as the hand would have a larger surface area than meat that is cut by a knife (Odell 2001:53). The presence of striations can also be a sign of prehension (Vaughan 1985:39). These striations are caused by grit adhering to the user's fingers that are then pushed into the tool's surface. Edges are likewise dulled, along with a polish development that may be enhanced by the oil on the user's fingers. Tools are not always held directly in the user's hand, but rather wrapped in leather or another material that protects the user's hand from the tool's sharp edges (Odell 1981:207). A tool's edges themselves are sometimes modified to avoid harming the user's hands. These edges are modified to produce blunter edges. While this is a useful morphological trait, this also means that less usewear develops as the edges are blunter and hence fewer microchips would form.

There are many features of a stone tool that can indicate if it was hafted and how it may have been hafted. There are a number of morphological traits that affect how and where hafting wear will develop. Hafted tools commonly have edges modified in order to facilitate hafting. This edge modification can obscure and hinder the identification of some signs of hafting (Rots and Vermeersch 2000:156). Shape in general can affect the amount of usewear created from hafting. The transversal convexity of a tool can alter the amount of hafting damage, as in the case of tools with a triangular cross-section. The greatest amount of strain of the hafting rests upon the high point of the tool at the triangular cross-section –ridge-, and results in a weak haft as it is only the high-point that connects to the haft. The shape of a tool can likewise encourage breakage. Wrapping tools greatly reduces the amount of hafting wear as this absorbs considerable amounts of shock and other forces. Wrapping additionally lessens the amount of friction that is generated between the tool and haft, along with protecting the tool's edges from scarring (Rots and Vermeersch 2000:160). Another morphological attribute of a tool that affects hafting wear is how much or little the tool extends from the haft. Obviously the working bit of the tool will extend beyond the haft, but sometimes the sides of the tool will also extend from the haft. This side extension, or overhang, provides greater pressure on the tool's edges and not the haft edges, producing a different form and placement of wear (Rots and Vermeersch 2000:160).

Although there are numerous signs, Keeley contended that observing and noting such evidence is not easy as hafting “traces are simply wear on tools which makes little sense as traces of utilization but does conform to what is known or expected of wear from minor movements of a tool against its haft” (Keeley in Cahen et al. 1979:681). Nonetheless, polish and scarring are the two most common signs of hafting (Rots and Vermeersch 2000:156; Rots and Williamson 2004:1288). Polishes, or bright spots are formed through intense friction with the haft and sometimes heightened through small flakes detaching from the tool's surface and then grinding against this surface as it is caught by the haft. The polished areas are commonly large and are concentrated in the proximal region and the haft limit. Striations additionally occur but are much more rare but sometimes delimit the extent of the haft. Another sign of hafting is rounding and smoothing of the tool's high-relief. Edge rounding was noted for hafted areas in

experiments, but these were not severe and occurred from polish formation under leather straps, and on high points buttressing the hafts (Rots and Vermeersch 2000:161). The type of material a tool is used to work can in addition have an affect on the hafted region's usewear. Hard materials such as wood will create crushing on the hafted area (Rots and Vermeersch 2000:160). Usewear located on illogical places on a tool is one line of evidence for the presence of hafting (Odell 1994:60; Pawlik 2000:170). This wear is less severe and extensive than that found on a tool's working end. The amount of pressure exerted while holding a tool will determine the amount of use that accrues on that tool's surface (Odell and Odell-Vereecken 1980:103). The angle in which the tool is held and the tool's edge angle itself will also affect the amount, type, and placement of the wear. The type of activity that a tool was employed in can in addition indicate that it was hafted. For instance, an earth working tool's usewear is quite easy to recognize as it extends all the way to the hafting area and then abruptly stops where the tool is covered in the haft (Keeley 1982). Residue analysis is another line of evidence for establishing if a tool was hafted, where the scant remains of the hafting material is recovered and this information is combined with the usewear, such as in analyses of stone tools from South Africa (eg. Jerardino 2001).

Whether a tool was hafted or not can raise a number of questions regarding such tools (Odell 1981:207). One such inference is that increases in the number of hafted tools over time can indicate sedentism, as suggested for the North American Eastern Woodlands (Odell 1994). In this case, hafting is a form of risk management in the realm of logistical forays. Such logistical forays held elements of risk where reliable tools were required, and hafting was considered a reliable feature.

A-1.1 Polish

Polish is the location on a material that reflects more light than other areas on the tool's surface (Keeley 1980; Jensen 1988; Kooyman 2000; Odell 2003; Rots and Williamson 2004:1288). Polishes are therefore recognized as a difference in reflectivity on a material's surface, a two-dimensional quality (Shea 1992:144). Polishes also have three-dimension aspects, such as flat, fluid, domed, or undulating appearances (Jensen 1988). Polishes are created through abrasive and frictional forces (Martindale and Jurakic

2006:422). Although, isolated patches of polish may instead be naturally bright spots of the lithic material or the product of unintentional wear (Vaughan 1985:27). It is crucial to note multiple areas of polish and to compare a natural piece of stone versus the culturally modified lithic to ensure that what is being viewed is from intentional wear. Nonetheless, many different types of polish exist and are idiosyncratic of particular materials (eg. Keeley 1980; Vaughan 1985:31-44). The shape and location of polishes can further indicate the type of activities or presence /location of hafting.

A developed polish surface is flat with little to no features (Kay 1997:652). Polishes develop through stages, a progressive process whereby the polish becomes increasingly flat, featureless, and smooth. This smoothness is a homogenizing of the stone's surface, but also occurs on other materials such as metal and bone. The development of a polish is differentiated based on its extent across a surface (Kay 1997). Another point of differentiation of development is the degree of polish, which is a measure of how homogeneous the polish is. Therefore, it is considered as either an extensively developed polish (EDP) or an intermediately developed polish (IDP). The longer a material is used and the harder it is, the more a polish will develop (Jensen 1988). As a polish develops it becomes increasingly bright. Polishes begin at the working edge of a tool along areas of high-relief (Jensen 1988). More developed polishes are the product of longer working times and they spread outward into areas of high and low-relief.

As strongly argued by many of polish' proponents, this form of wear can only be reliably observed and characterized using the high-power method (eg. Keeley 1980; Grace 1990; Dockall 1997). Metallurgical microscopes are commonly used to observe polish and SEM's (scanning electron microscopes) are also commonly used. Polishes are usually observed and characterized between 100 and 300x magnification (Jensen 1988). The low-power approach was advocated only for noting the location or general presence of polishes (Odell 2003). This step is used to separate those artifacts that warrant more attention, which is especially critical as the high-power approach involves a considerable amount of time, and with an SEM, money.

Some researchers believe that polish can be objectively defined based on three parameters: the degree of development: the polish's pattern: and the texture of a polish

(Gonzalez-Urquijo and Ibanez-Estevez 2003:481-483). Polish development is the amount of area that a polish covers on a tool and refers to the amount of tool surface area contacted the worked material. Polish development can similarly reveal differences in the application of pressure when a tool was used. Polish pattern relates to where the polish was found and delimits that portion of a tool that was or was not in contact with a material; a polish's pattern also adds greater validity to proving that polish is a valid component to a usewear study and suggests that this is not a natural phenomenon but a product of a tool's use. Finally, a polish's texture looks to the *regularity of the polished surface*, which can be contrasted against other forms of polish to distinguish what type of material formed that particular polish; hence each type of material, whether soft or hard, will have their own diagnostic polish texture (Gonzalez-Urquijo and Ibanez-Estevez 2003:483).

Lithic Material Type

Polish can be found on any type of stone material, but polishes develop differently according to the type of stone they are found on. Glasses and other fine-grained materials develop polishes more readily and robustly than coarser materials (Jensen 1988; Martindale and Jurakic 2006:422). These finer-grained materials similarly have polishes that go through the developmental stages much faster than coarser-grained materials. In looking to differences of grain sizes for flints, polishes developed the same in respect to their characteristics but not size (Vaughan 1985:27). Fine-grained flints developed polishes more quickly and in broader patches /sizes. The polishes on larger grained varieties were the opposite and these were overall weaker. Some authors have also argued that knowledge of how polish develops on one type of chert, for instance, is applicable to all types of chert (eg. Vaughan 1985). Others have disagreed with this as all lithic materials break differently and some polishes can be a product of natural weathering or a stone has a naturally highly reflective surface that can be mistaken for polish (Brian Kooyman personal communication 2006).

Stages of Polish Development

Over time as a tool is used polish increases in intensity, dimensions, and other factors. This development occurs in recognizable stages. A tool used for a short period of time

develops a *generic weak polish*, which is one of the first forms of polish to develop (Vaughan 1985:28). Generic polishes develop no matter what kind of material the tool was used to work and are common on finer-grained materials. This is where polish develops in small patches on areas closest to the edge and over time extends to the higher-relief areas away from the edge. This stage of polish is characterized by its flat and dull, but also stucco-like surface, with slightly terraced edges (Vaughan 1985:28). These polished areas are small. Dull polish is slightly brighter than the stone's natural surface. Some pits may be present in the polish but it is overall smoother than the natural surface.

The initial form of polish develops into other forms of polishes in a step-like progression of stages. Over time, small areas of generic polish slowly conjoin to produce larger areas of polish. Polish episodes can similarly overlap. This occurs when a tool is used for different tasks or if it set down in between periods of work. Recognizing the overlapping of polishes is difficult and can be best achieved when a weakly developed polish overlaps a stronger polish (Vaughan 1985:40).

Generic weak polishes gradually develop into *smooth-pitted polishes* when a tool is used for longer periods of time. Like its namesake, this second form of polish is characterized by its smooth surfaces with small micro-pits (Vaughan 1985:28). These pits are quite small and even smaller dark interstitials can appear in the polish. The pits are unpolished areas representing unconnected polished areas; this is deceptive wording for when stating *pitting* one would think there were pits dug into the stone itself and not simply the absence of polish. A third, and final form of polish is *filled-in polish*. The pits eventually fill in, creating larger patches of polish. Polish is additionally now found in areas away from the edges and is sometimes found in the tool's interior regions near the working edge (Vaughan 1985:29). Both high and low-relief areas can become polished at this time as well.

Simpler divisions of polishes are mild and severe polishes. These types of polishes are a product of both differences in material types and time it took for the polishes to develop. A mild polish is when there is a transfer of a small quantity of material (Donahue and Burroni 2000:142). Severe polishes occur with larger quantities and sizes of materials. The severe polish tends to be rougher and has less reflectivity than

the milder polish. In addition, polishes with well defined edges are believed to be harder than those without. The formation of harder polishes is also believed to be the product of a gradual process (Donahue and Burroni 2000:142).

Material Specific Polishes

There are multiple variations in polishes that can indicate what type of material formed the polish (Grace et al. 1985). Vaughan (1985:32) places emphases on how polishes are different because of the amount of *sustained contact* with a particular material, or length of tool use. This plays into the material's hardness, as the softer a worked material is the more a stone tool can penetrate it and hence have a greater amount of sustained contact. Polishes that take a long period of time can be quite bright. Further, polishes made from certain material interactions such as stone tools that worked plants, can also produce bright polishes. The level of polish brightness can therefore be used to understand how that polish formed.

A note of caution needs to be mentioned when defining polishes. Although polishes are distinctive to material types, there is also a degree of overlap (Grace et al. 1985; Gonzales-Urquijo et al. 2003). This overlap is the result of how polishes develop on a scale, where a polish forms gradually and *time* is a crucial factor; however, Grace et al. (1985:118) contended that time was not responsible for polish formation, such as "edge morphology in relation to use motion". For instance, a stone tool used on wood for only a short time will not have a well-formed polish and this may resemble the polish from working a softer material. Through analyzing a larger area of polish accuracy is improved in identifying how the polish was produced.

Material Specific Polishes: Wood

Wood polish is characterized by its smoothness (Martindale and Jurakic 2006:422). Polish is evenly distributed across the working edge of a tool used to work wood. The softer the wood the faster the polish develops as this will allow more of the tool to penetrate the wood's surface. Sawing wood produces polishes that are bright with smooth pits (Vaughan 1985:34). These polished areas are also larger than those created through working bone or antler, but smaller than those produced by working softer plants. Although, some authors discuss wood in its entirety and do not consider the difference

between portions of wood: bark, core, limb, root, or knot (eg. Vaughan 1985).

Furthermore, it is rare for authors to differentiate between many wood species and ages (green, seasoned, or driftwood).

Material Specific Polishes: Antler

Antler has an anisotropic structure (Rots and Vermeersch 2000). A tool used to saw antler cuts across this structure and this produces uneven amounts of contact between the tool and antler (Vaughan 1985:32). Actions such as scraping, grooving or planing instead work with the antler's grain. Sawing antler produces bright and smooth-pitted polishes close to the tool's working edge. Antler polish is very similar to wood polishes (Rots and Vermeersch 2000).

Material Specific Polishes: Bone

Bone polishes tend to be localized to the specific working areas of a tool (Martindale and Jurakic 2006:422). Sawing bone produces polishes that have bright and smooth pits and grooves that bisect the polishes (Vaughan 1985:31). Pits are more common in bone polishes than in wood polishes. Comet-tails are too sometimes found in the interiors of bone polishes. Microchipping is also common, which removes much of the polish (Martindale and Jurakic 2006:422). Working bone, in particular with sawing actions, produces polishes that are very similar to antler polishes except that antler polishes do not have bisecting grooves (Vaughan 1985:31).

Material Specific Polishes: Dry hide

Dry hide polishes are commonly very dull in appearance and can be pitted with a frosted appearance on the upper surface of the polish (Vaughan 1985:37; Martindale and Jurakic 2006:422). These polishes have a wide distribution across the working edges of a tool (Vaughan 1985:37). Rounding of the tool's edges also accompany the polish, along with numerous striations when the hide is worked in a sandy environment. There is, even still, some disagreement on whether different animal species' hides produce different types of polishes; Vaughan (1985) suggests all hide polishes are the same while Hayden (1979:226) disagrees.

Material Specific Polishes: Flesh

Flesh can be either muscle or skin /hide tissues of an animal. Working of these tissues produces dull polishes that generally form only generic weak polishes (Vaughan 1985:38). Polishes are common in high-relief areas and form a thin band along the working edges.

Material Specific Polishes: Soft Plant (sickle polish)

Soft materials in general tend to develop the third stage of polish much more slowly than harder materials (Vaughan 1985:29), but no matter the plant species the polish is the same. Plant polishes are moreover referred to as *sickle gloss* (Moss 1983; Vaughan 1985). Vaughan (1985) argued that the silica in plant tissues forms a gloss on a tool's edge—an additive process. Polishes from soft plants are commonly brighter than the previously mentioned polishes. Reeds, a harder type of soft plant, can produce bright and smooth-pitted polishes when the tool is used extensively (Vaughan 1985:35). These polishes can become domed and sometimes linked. Polishes from working other types of soft plants are also extremely bright but will have small pockmarks across their surfaces. Polishes tend to be conjoined and widely spread across a tool's surface, extending outward from the working edge. Striations in addition occur but are commonly 'filled-in' with polish. Comet tails also sometimes appear on the surface of the polishes (Vaughan 1985:36)

Lubricants

Adding a lubricant reduces friction between two opposing materials. Adams (1988:313) argued that "friction heat is one indication that wear is occurring, and the resultant surfaces appear attrited [removed], rounded, glossy, and striated". Lubricants reduce frictional heat while also controlling the degree and scale of polish formation (Dowson 1979; Samuels et al. 1981). Microchips, striations, and rounding become less severe with the addition of lubricants, but the lubricant itself can add to the development of polish (Shea 1992:144; Jacobson and Hogmark 2009:378). This is because the lubricant can become attached to the material's surface, filling in low-relief areas and making the surface smoother and more reflective: polished. Reduced frictional forces can still warm a lubricant and harden it as it infills the low-relief.

Ethnographic studies documented wetting materials, such as hides, to make them more pliable, and hence more easily worked (Rots and Williamson 2004:1293). When stone is used to work hides, polishes form in large areas of the tool's surface because the softness of the hide allows it to cover more of the surface area of the stone (Adams 1988). Added water hydrates dried blood inside the hide, allowing the tool to glide across the hide more easily and hence with less friction. As indicated by usewear studies, water "affects the rate of surface smoothing" (Grace 1996:212), possibly by hydrating the stone and increasing its plasticity. The more lubricant that is present on a tool's surface, the less wear and friction will result as that thin layer of lubricant maintains a separation of the worked and working materials (Jacobson and Hogmark 2009:378).

Lubricants are in addition questioned in reference to their *viscosity*, which is defined as "resistance to flow...[as] Sir Isaac Newton defined it as the resistance that arises from lack of slipperiness in a fluid. Cold maple syrup is thick and not slippery, but cold water is thin and slippery" (Anderson et al. 2006:1563). This reasons that not all lubricants work equally well and that such differentiation may have been considered by past cultures. For instance, some groups used fat instead of water to act as a lubricant when processing hides (Vaughan 1985:37). Polishes and edge rounding developed more slowly when fat was added. Such polishes tended to be more pitted than polishes formed from working hides without the aid of fat.

Location /Action Inferences

The location or positioning of polish can furthermore be instrumental in demonstrating if a tool had been hafted. This can be inferred macroscopically and through the low-power approach through searching for isolated patches of polish at the proximal end of a stone tool. Hafting polish is commonly identified on surfaces of high relief, such as the tops of flake scars, or the edges /outer regions of a stone tool (Frison 1968; Gonzalez-Urquijo and Ibanex-Estevez 2003). The width of a polish, or how far a polish extends from the edge of a tool is directly related to how deep a tool penetrated a material -the hardness or softness of the worked material (Martindale and Jurakic 2006:422). Polish from working hard materials is generally restricted to the edge of the lithic tool, as this hard material is not plastic. On the other hand soft materials such as hide, plants and flesh are pliable and working them tends to produce polish that cover a greater amount of surface area on a

stone tool, including depressions of flake scars and areas further away from the tool's edge. So in analyzing a stone tool for the presence of polish, signs of polish in the recess of a flake scar can indicate a soft to medium material, while polish restricted to the areas of high micro-relief indicates contact with medium to hard materials. Further, hafting inference is commonly bolstered by the presence of edge rounding and chipping (Anderson and Chabot 2001).

The direction or motion that a tool was employed in can also be gauged through observing polish at the macro or low-power scale (Driskell 1986; Anderson and Chabot 2001). The morphology of a polish can indicate such movement. For instance, the direction of oval or linear polish would be that of the tool's movement as these polishes represent where two materials made contact. In another instance, linear polish on a projectile point tip can suggest that it had been withdrawn from the kill (Dockall 1997); this type of polish forms from the rubbing of the stone projectile point against the flesh and hide of the killed animal. This same polish in areas of hafting can indicate the direction the tool was used, whether the haft was weak or strong, and how the haft and tool fitted together.

Additive vs. Subtractive Theories

How polish develops has been a subject of debate in archaeology. This debate, which has decreased in the last two decades, was between additive and subtractive camps, or combinations of both. The silica-gel theory proposes that silica from worked plant material forms polish on the surface of a stone tool while another theory maintains that it is silica that originates from the stone tool itself that forms polish (Kaminska-Szymczak 2001:111). Another archaeologically derived idea is that polishes are a combined effect of chemical and mechanical processes (Kaminska-Szymczak 2001:111), which is similar to the mechanical engineer's *delamination theory of wear* that considers polish a product of both additive and subtractive phenomena which specifically discusses a material's level of plasticity (Suh 1981:151). This section considers this theory first and then discusses the archaeologically driven theories of silica-gel and abrasive theories.

Delamination Theory

Addition in polish formation means that part of one material is added to another material (Samuels et al. 1981; Suh 1981). Friction is produced as two materials come in contact, which dislodges part of one material and adheres it to the other material (Samuels 1981; Unger-Hamilton 1984; Smit et al. 1998; Smit et al. 1999). As one might assume, this concept of addition also involves substitutions since material is both lost and gained. Polish is then formed through the removal of high-relief and filling in of low-relief (Suh 1981:51). Plastic deformation similarly occurs, where no material is added or removed, but rather redistributed across the surface of a material (Suh 1981). Kinetic energy moves across the material's surface as it continues in contact with another material. This energy is focused on the portions of the surfaces that are in contact, which is the high-relief areas of these surfaces. This kinetic energy is what propels portions of a material's surface to be redistributed, taking advantage of that material's plasticity. There is a limit however, to the plasticity of any material, for it will continue to alter shape, redistributing surface area until the limit is reached when that portion of the material's surface snaps. This involves removal of high-relief areas, making the material's surface smoother. When the snap occurs, the kinetic energy stops traveling and building-up through the material's surface and now a new area of the material's surface will begin to be altered with the building-up of kinetic energy for plastic deformation. Further, the now snapped-off section of the material's surface is dislodged; it can create friction as it is caught between the two worked materials to form striations, or it can become adhered to one of the material's surfaces to fill in low-relief areas and add to the development of the polish. These changes to a material's surface are understood as the *Delamination theory of wear* (Suh 1981). This theory has also been quantified by engineers into a mathematical formula ($V=KS/3$) to better understand the hypothetical conditions of wear. (Samuels et al. 1981:15). Samuels (et al. 1981:15) explained the equation as:

“V is the volume worn away, S is the sliding distance, L is the normal load, H is the indentation hardness value of the softer of the wearing pair, and K is a constant which effectively is required to make the formula fit reality within an order of magnitude.”

Another example of quantifying polish comes from Smit et al. (1998) research, where it was indicated that polish was additive. Further, their research also produced maps of

where the polish was distributed, indicating the possible motion of the tool and polish developmental stages.

The removed and adhered material can be of different shapes. Such shapes are not indicative of particular material contacts, but rather different forces such as plastic deformation or sub-surface cracks (Samuels et al. 1981:15). In a recent mechanical engineering study, a stone drill bit, was used to pulverize raw stone (Jacobson and Hogmark 2009:373-4). The force of the drill contacting the raw stone produced a microscopic layer of the raw stone mixing with the drill's stone. While the amount of force applied to the stone drill is far greater than any force used prehistorically, the principle that stone interacting with stone could produce such an additive polish is intriguing and provides a further possible avenue for explaining stone polish.

Additive polishes were noted in the 1950s by engineering researchers, Bowden and Tabor (in Donahue and Burrioni 2000:141). Their work argued that additive polishes are produced by strong cold-welds that are created on a material's high-relief. This polish can then sometimes be removed because it hinders the tool's ability to work. This removal, or shearing, can erase the presence of the polish. Any visible polish is therefore the product of the final intervals of action between a tool and what it had worked. Furthermore, shearing suggests that polish is a result of both additive and subtractive processes since material is being removed from high relief that would result in the material becoming smoother and more homogenous; therefore, more reflective.

Silica-Gel Theory

In the realm of additive theory as espoused above by engineers, is the archaeologically derived *silica-gel theory* (Jensen 1988:55). Silica-gel polishes always form when a tool is used to work plant matter (Jensen 1988:58; Kaminska-Szymczak 2001:111). According to this theory, polishes form under a combination of actions such as friction and pressure (Jensen 1988:58). Water trapped in the stone tool escapes and aids in the formation of the gel. The combination of ingredients and actions produces a hardened sheen on the tool's surface that is smooth and reflective. The plant's silica is layered onto the surface of the stone tool and gradually hardens. Cleaning of the stone tools might affect polish,

especially if polishes are additive and made from plant residues. Harsh acidic cleaners have been suggested to dissolve or alter polishes.

The silica-gel theory was proposed by Anderson-Gerfaud (1988:188) who noted that “during utilization, plant phytoliths seemed to be trapped on the surface of flint by a substance that she interpreted to be silica gel”. These phytoliths, or silica particles are compressed into the tool’s surface and change “the surface microtopography of the affected area so that it reflects an increased amount of light” (Shea 1992:144). This indicated that polishes are additive, and further studies have indicated that such crusts are high in calcium, carbon and oxygen (Kaminska-Szymczak 2001:119). Polishes tend to be brightest when grasses or bamboo are worked, but the same theory is also applicable to woodworking and soil tilling both of which produce slightly less bright polishes (Shea 1992:144). The polishes from working animal products are even less bright and have a matte finish (Shea 1992:144). Under magnification, phytoliths were observed on the tool’s surface embedded in the polish. However, other researchers have had mixed results in observing adhered phytoliths; Grace (1989; 1996) did not find evidence for phytoliths, while Mansur (1982), Kaminska-Szymczak (2001), Kealhofer et al. (1999) and Anderson and Garuf (In Kaminska-Szymczak 2001) did.

Support for the silica-gel theory has moreover been provided by studies that utilized an ion beam analysis, which was furthermore the first technique to indicate an elemental characterization of polishes (Anderson and Whitlow 1983; Jensen 1988:58). These analyses produce evidence that polishes are amorphous silica layers that fit the previously mentioned silica gel theory. The ion beam analyses indicate that polished areas have a higher level of hydrogen in contrast to the surrounding natural stone, proposing that the polishes are comprised of trapped water perhaps from the stone and worked material. Furthermore, this analysis supported the possibility that polishes could be differentiated according to their thickness (which is directly related to the wetness and hardness of the worked materials). Christensen (et al. 1998, Odell 2001:52) came to similar conclusions through using a SEM with an energy-dispersive X-Ray spectrometer. This equipment showed Christensen that small pieces of bone were lodged on the stone’s surface and insinuated that polish was an additive process. These pieces were found lodged in the smallest of recesses of the tool’s surface, making it more homogenous and

hence polished. Energy dispersive X-Ray spectroscopy (SEM EDS) has also been used to analyze a polish's chemical composition (Kaminska-Szymczak 2001:112). Nonetheless, this equipment has limitations in that "a spectrometer measures chemical composition not only of the very surface, but further, some distance below the surface depending on the porosity of the analysed (sic) matter" (Kaminska-Szymczak 2001:112).

An intermediary theory between silica-gel and the below discussed abrasive theory suggests that silica from the stone itself becomes redistributed as polish (Grace 1996). This theory was used to explain how soft materials could produce polish if polish was truly an abrasive process. As silica is removed or abraded from a tool, this silica is then "embedded in the worked material and thus polished surfaces are created by silica abrading silica" (Grace 1996:212).

Abrasive Theory

Subtractive polish, or the abrasive theory, is the removal of material from a stone's surface, making it progressively more homogenous as more material is removed. This is a shearing process where high topography is removed, flattening out the landscape. Grace has consistently argued that the argument for polish as an additive process is unacceptable and, as far as research goes, "proven untenable" (Grace 1996:211 In Odell 2001:52). Yamada also supported the subtractive role in his experiments when he analyzed the changes on one small portion of a tool as it was continuously used (1993 In Odell 2001:51-2).

Grace (1990) argued that *most* archaeologists have accepted the abrasion theory and dismissed the additive theory; however, Grace is likely in the minority of this view. Yamada conducted a series of experiments that would seem to support Grace's opinion (in Grace 1996). As a stone tool was used, Yamada took casts of the working area of that tool. These casts were analyzed with an SEM, with results that indicated that polish was an abrasion on a tool's surface that resulted in gradually smoother microtopography.

Glass also develops polishes and is similar in morphology to obsidian, a natural glass (Shea 1992:144; Odell 2001). Glass polishing is a subtractive or abrasive process, which is the tribological, or abrasive theory. In experiments with obsidian tools, the tools' surfaces became weakened through abrasion (Hurcombe 1992). Striations additionally appeared on the weakened surfaces that simultaneously were attacked by chemicals

excreted by the worked materials. This experiment suggested that polishes were formed by a combination of subtractive, additive, and chemical forces, and that polish does not form in isolation but rather simultaneously with other forms of wear such as striations (Odell 2001:52). Rabinowicz' molecular theory supports the idea of polish as a product of "mechanical removal of material and subsequent chemical attack, enhanced by water and abrasives, resulting in a thin surface film" (Odell 2001:52).

Corrosive, or chemical wear is another form of subtractive theory on polish formation. Corrosive wear can take place with water. Water, as discussed earlier, was sometimes used as a lubricant when working hides and other materials. Water can act as a corrosive when used on stones such as obsidian and microcrystalline silicates because the water combines with the silicates to form an oxide film under the heat and pressure (friction) and this results in enhanced wear (Donahue and Burroni 2000:141). This corrosion can reduce the topography on a stone's face, producing a more reflective and homogenous patch.

Fractal Geometry & Computer Imaging

Fractal geometry is a flawed, yet promising, approach to characterizing and objectively recording stone tool polishes. This technique uses a high-powered approach to visualize polishes in a way similar to that of the human eye, except this technique uses digitally captured images of the polishes and organizes the image according to levels of intensity (how much light is reflecting off the pixels) (Rees et al. 1991). This method was constructed to address previous arguments (ie. Keeley 1980) that polishes were idiosyncratic to the material that made them, but the arguments to support these assumptions were subjectively framed. Fractal geometry offered an objective means of relating worked material to polish and doing so in a replicable fashion. Fractal geometry is based on Mandelbrot's work who "observed that many patterns in nature (point distributions, curves and surfaces) appear to be of self-similar fractal form (such as coastlines which 'look' the same at different scales) and furthermore that natural eroding processes generate surfaces which have fractal properties" (in Rees et al. 1991:630). These patterns are spatial distributions that are statistically relevant. The distributions are recorded in either 2 or 3 dimensional spaces, which is important, as a rough surface will comprise more of a 3-D space than a smooth surface; implying that a polish will have a

lower value than a non-polished or early phase polished surface. The potential in this approach is that the current technology behind computer scans are reaching a point where they may be used to capture images of stone polishes /wear. These images hold more data than what Rees et al. (1991) were working from and could give much more relevant quantitative results of changes in a material's surface topography without the need of mathematical equations such as fractal geometry.

After a positive first application of fractal geometry to identify, quantify, and link a polish to a specific worked material (Stemp and Stemp 2001), the technique was then used to differentiate stages of polish through the application of the UBM laser profilometry technique (Stemp and Stemp 2003). The results showed that while some tools did go through regular stages of polish development, when working harder materials such as wood and pottery did not go through regular stages (Stemp and Stemp 2003:293). Stages did occur, but the stages could not be measured and were not regular. Nonetheless, there were stages observed for different material's polishes. These stages indicated that the overlap between polishes might be smaller than previously assumed.

Computer imaging programs have also been used to characterize polish (Shea 1992:148-9). This approach utilized an *Image* (version 0.92) computer program to analyze the pictures taken of a specimen under the lenses of a microscope. The luminance profiles of the images are studied by the program to characterize the polish, removing potential human error from their analysis. These images are formed of pixels that can be differentiated according to their shades of grey, of which there are 256 shades (Rees et al. 1991). These shades are arranged from lightest to darkest, the lightest representing polished areas. There will always be an element of subjectivity when characterizing polish, as it is sometimes a product of or influenced by the natural lithic material itself, not to mention the microscope and light source(s).

The application of PIXE (Particle-Induced X-ray Emission) analysis is another recent method applied to understanding polish (Christensen et al. 1998). Again, the three thoughts on polish formation are that it is either additive, subtractive, or a combination of the two processes. PIXE identifies the individual elements that compose an object by penetrating only a shallow uppermost layer of a material in its analysis (Pappalardo et al. 2003). This is also a nondestructive technique, and so is ideal for irreplaceable artifacts.

As such, PIXE can eliminate or support the idea that polish is additive or subtractive; consequently this process also has applications to residue analysis. Christensen et al.'s (1998) study looked at experimentally utilized chert tools. While their analysis is informative it is additionally hampered by the lack of contextual information. For instance the authors do not discuss how the tools were cleaned following their use; some authors claim that acid cleaners can remove polishes, and hence this would alter Christensen et al.'s (1998) results. This study also does not mention how many tools were analyzed, for polish does not develop on every tool used, and is additionally likely time sensitive, which again is not mentioned in their methodologies. Furthermore, and more importantly, this study laced their stone tools with copper as they found that the copper was better viewed under the tools they were using (PIXE). The inherent problem with this is that they do not address whether copper is a suitable analogy for stone. Does polish manifest itself in a similar way for both copper and stone? This is doubtful as engineering results on polish differ from what is discussed archaeologically because engineers are interested in the wear present on metals and archaeologists are interested in stone and early metals. While the techniques and theories advocated in engineering studies can be applied to archaeological studies, their results cannot.

A-1.2 Striations

Basically, striations are scratches on a tool's surface (Hayden 1979:213). They are created by a tool working a material, where a projection on the worked material or a foreign material like grit becomes sandwiched between the two surfaces and scratch the tool's surface (Vaughan 1985:25). Striations are commonly found on the tool's leading edge that worked a material. The shapes of striations consist of straight lined grooves, although the edges and troughs of these grooves vary. These carved lines are the product of either intentional or unintentional means, such as soil movement during burial (Shea 1992; Rots and Williamson 2004:1288).

Striations can form during the process of polish formation (Vaughan 1985). During this process, a striation will be influenced by how hard or soft the polish is at the time. According to the previously discussed silica-gel theory, a polish begins quite soft as it is still a melted mass of silica, influencing the creation of blurry and soft edged striations (Mansur 1982). As the polish hardens, the previously formed striations may fill-

in with newly formed silica layers and new striations can also be formed on the now hardened silica layer but these will be crisper in appearance. Such distinctions of striae can only be deduced via the high-power method, but otherwise striae are commonly characterized utilizing the low-power method.

Formation of striations can be understood through the idea of *three-body abrasion* (Donahue and Burroni 2000:141). The three bodies are the tool, the worked material, and the trapped foreign material in between the latter two. Foreign materials are grit and other particles natural to the environment that a tool is used in, or they can be chips that were dislodged from the stone tool's surface during use (Mansur 1982:216; Vaughan 1985:25; Donahue and Burroni 2000:141; Rots and Vermeersch 2000:162; Martindale and Jurakic 2006:422). In the case of hide working, such detached microflakes can embed themselves in the skin and continually scrape the tool's surface (Hadyen 1979:226). The hide itself can additionally create a form of glue that secures that dislodged microflake in place and the frictional heat can promote microspalling along the tool's edge. The lithic material also affects the formation of striations. The elasticity of a lithic material can dictate if striations form and how many form (Jensen 1988:54).

Inference of Material Type

Striation shape is relative to the shape of what created it and the width is related to the size of the particles (Jensen 1988:54). In essence, a striation is a negative relief of a worked material's surface. For instance, larger particles will leave larger striae, and sharper particles will leave more v shaped striae (Mansur 1982:217). A rigid material may have been worked if striations are found parallel to the working edge (Shea 1992). These types of striations additionally have well defined borders. Softer materials can instead produce striations that run obliquely to the tool's edge. Borders on striations made by these softer materials are also softer and less defined than those made by harder materials. Inferences cannot be made more specific than this and can only be argued for when striations are found in association with other forms of wear (Jensen 1988:54). Shapes are commonly recorded as various degrees of roughness or smoothness. The number /quantity of striations is another attribute. This number is dependent upon the amount of abrasive particles. The presence of these lines caused by foreign particles can

suggest what the natural environment was like -where and when that tool was used –for example, numerous thin striations may indicate a sandy and perhaps windy environment.

Striations are common during hide working (Adams 1988). Sediment and other small pieces of grit easily become incorporated into the actions of working a hide, and as the hide is pressed into the stone tool, the grit and sediment become pushed between the two materials and slide across as the hide is worked. The sliding and pushing of the particles can form small gouges or lines in both the hide and stone. This is similar to the results of metal axe blade use where grooves and raised pieces of the blade will create negative relief marks on the wood that was worked (Sands 1997:5).

Mansur (1982) disagreed that striations are a common result of hide working activities. Striations were also claimed to be rare or absent in tools used to work meat. Instead, Mansur proposed that hide and meat working resulted in increased edge rounding and smoothing. On the other hand Mansur (1982) did contend that working wood and bone produced striations. The distal tips of projectile points for instance, have diagnostic striations that are the result of penetrating a target like bone or soil. Bone working is considered to be one of the more common striation-producing activities, followed closely by woodworking. Any portion of the bone or wood that becomes dislodged or split upwards can easily scratch a tool's surface.

Inference of Motion /Environment /Hafting

The presence of striations can provide evidence of the past motion and activity a tool was used in, as well as the environment of when it was used. In addition, striations can additionally indicate if the tool was hafted. Dusty atmospheres and gritty contexts encourage the development of abrasions /striations as these foreign particles can become trapped between the tool and another material, be it a haft, the hand, or processed material (Tringham et al. 1974:184). Striations that are found only on the proximal half of an artifact indicate hafting (Hardy and Garufi 1998; Rots and Vermeersch 2000:162; Hardy et al. 2001:10973). The presence of striations alone cannot prove hafting, but they do add support to the argument for it. Other lines of evidence such as residue analysis (residues from mastics or binding materials) are also used to argue for the presence of hafts.

A tool's motion is indicated by the orientation of striations, with striations running parallel to the motion that a tool was employed in (Rots and Vermeersch 2000:162). Crisscrossing striations may indicate that the tool was used in an alternating diagonal direction, while parallel striations with minimal crossing suggest a back and forth movement, and finally parallel striations with no crossing indicate unidirectional movement (Vaughan 1985:25). Scraping or adzing actions often produce striations that are perpendicular to a tool's edge (Shea 1992:144; Martindale and Jurakic 2006:422); these types of actions are likewise referred to as *edge-transverse motions* (Vaughan 1985:25; Shea 1992:144). Transverse actions can also result in striations forming primarily on the portion of the tool that was actually in contact with the material –the ventral or bottom of the tool (Vaughan 1985:25). If a tool is tipped in an obtuse or high angle, then striations can form on the tool's top surface. Striations from cutting actions are diagonal or parallel to the tool's edge (Martindale and Jurakic 2006:422); cutting is furthermore referred to as longitudinal action (Vaughan 1985:25). Nonetheless, in experimentation there was found to be some overlap (between 9 and 14% overlap) in the orientation of striations according to specific motions (Vaughan 1985:25).

Lastly, variations in depth can be used to differentiate striations (Vaughan 1985:24-25). The depth of striations can infer the force that was applied, or the *static load*, as a deeper striation implies more force than a shallower striation (Dockall 1997; Martindale and Jurakic 2006:422). A striation's depth also differs according to the ends of the striation. So the beginning or starting point of a striation is usually deeper than the end of the striation because the particles from the striae will lift and eventually are removed from the contact material as it slides. Depth is commonly recorded by measuring the shadow viewed inside a striation and is similar to the approach taken by researchers who study bone cut marks (eg. Polio 2009). Measured differences divide striations into deep or superficial classes. These classes signify the amount of applied pressure to a tool and the hardness of a worked material (Mansur 1982; Martindale and Jurakic 2006:422). The depth is too affected if the striation was formed on a polish. Striations can then be deeper if the polish is softer and shallower if it is harder (Mansur 1982).

A-1.3 Microchipping

Microchipping is the removal of small pieces from a tool's surface that can be analyzed with magnifications *below* 100x (Jensen 1988:54). These removed pieces have specific shapes that are related to particular actions or materials connecting the tool's surface. Use microchips are rarely larger than 7mm; yet, they vary according to lithic material, and rejuvenation and other flakes removed during flintknapping processes are much larger than this (Kooyman 2000). The actual flake itself is not present but rather the outline of that flake in the form of the negative relief scar or fracture scar where the flake was removed. The edge of this scar is called an *arris*, which is defined as "a ridge that is formed by the intersection of two surfaces and it defines the extent of a fracture scar in one or more directions" (Donahue and Burroni 2000:142).

Microchipping is based on fracture mechanics, which argues that stone flakes in predictable and patterned ways (Donahue and Burroni 2000:142). This is the same principle behind flintknapping. Forces such as bending and shearing are what commonly create these chips (Shea 1992:143). These forces stop when the lithic material fails, and the force exits the stone, thereby removing a piece of the material. The forces will not only remove material but also weaken the surface of a tool, leaving fractures under the stone's surface (Donahue and Burroni 2000:141). Cracks can additionally form during this process. There are four types of microchips. The first is a feather-terminated chip where the scar has a soft roll from beginning to end (Odell and Odell-Vereecken 1980). Hinge chips are different in that the scar's end rolls upwards. The third, step, has an end that abruptly stops at a near 90 degree angle, like a step on a staircase. The final type is called a snap chip /fracture, and this form bisects a piece, where the flake scar crosses the ventral and dorsal sides, commonly associated with a piece breaking in two.

Straight edges produce more chips than curved edges because the straight edge has more surface area to connect with the worked material (Tringham et al. 1974:179). A change in how the tool is held can also influence the number of microchips produced. How a tool is handled dictates the direction of the tool's force and is additionally affected by the angle of tool's physical edge (Odell 1981:197-9; Shea 1992:143). This changing angle can direct the force of the impact more or less into the center of the stone tool,

resulting in deeper or shallower microchips. As the horizontal orientation deviates from 0, the microchipping will be orientated to that same deviation.

Location of microchipping is also informative. If microchipping is present on the dorsal surface but not the ventral surface, then it was the ventral surface that was pushed forward across the material's surface (Odell 1981:201). If microchipping is present on both of the tool's faces, then that tool was pushed in two directions, back-and-forth. The reason for this is in that as the tool is pushed one way, the force of the push pulls at the opposite side of the tool. This push-pull force can dislodge material on the backside of the tool as the front side is being supported by the worked surface it is being pushed into. The shape of the edge can additionally effect the formation of microchipping. When the leading edge is flat, then the microchipping tends to be closely spaced or overlapping and fairly large -visible to the eye (Odell 1981:201). When the leading edge is instead round, then the microchips are much less noticeable, smaller, and more spaced out. The reason for this difference is that a flat leading edge produces "forces causing breakage [which] are likely to proceed along vectors approximately parallel to at least part of the curvature of the convex surface" (Odell 1981:201). A second reason is that the flat leading edge provides a better platform for chips to be struck from than the rounded edge (Odell 1981:202). The distribution of microchips can indicate which edges were used. Transverse actions often result in microchips that occur on only one face (Vaughan 1985:20). This face is the one opposite to the face that was in actual contact with the worked material; this is unifacial microchipping. Longitudinal actions instead create microchips on both faces of a tool. The length of time that a material was worked also has an effect upon the wear, for the greater the length of use (40 versus 4000 scraping strokes) the more recognizable the wear (Odell and Odell-Vereecken 1980).

Microchipping moreover removes other forms of wear. Striations or rounding, or additions such as polish or accretions, develop and interact with only the outer most layer of an artifact and so the smallest amount of material removed from a stone's surface can also remove all traces of this use (Donahue and Burrone 2000). The remains of the microchips provide important information about the surface usewear. These flakes are minute in size and often missed during excavation, but when collected can hold a wealth of information. In particular, this information can be used to reconstruct the life-history

of a tool and signify if it was used for more than one task during its use. The downside to this task is that it is logistically difficult to prove a relationship between microchips and particular artifacts at a site. The relationship between fracture scars and use can in addition be informative and is guided by two principles. The first principle is that “if wear exists on the surfaces forming an edge or arris, then that edge and its defining surfaces preceded the processes that produced the wear” and secondly “if wear exists on a surface but does not extend onto the surface of an adjoining fracture scar including its defining arrises, the then processes that produced the wear preceded the formation of the fracture scar” (Donahue and Burroni 2000:143). These two principles allow for the reconstruction of an artifact’s life-history as based on the removal of microchips and retouch flakes.

According to Material Type

The harder a material, the more force required to work it and hence more force would be directed into the lithic tool for chips to be removed (Shea 1992:143). Forces from hard materials will dislodge larger pieces from the tool because of the increased force needed to work that material. Lithic materials such as chert, chalcedony, quartz and basalt react the same with microchipping, but less force is needed for more brittle obsidians (Odell 1981:198)

Microchip shapes are indicative of the hardness or softness of the material that the artifact was used on (Hayden 1979:210; Odell and Odell-Vereecken 1980; Vaughan 1985:21). Such associations between worked material and microchips are a guideline and not a firm rule (Vaughan 1985:21). Nonetheless, overall shapes and cross sections are the two features used to distinguish microchips (Hayden 1979:210). Overall, microchips have crescentic, pointed, expanding, and lamellar when microchips are viewed from above. Observing microchips from the side provides the cross section, which can be labeled feather, bending feather, shallow hinge, deep hinge, snapped, break, retroflexed, bending hinge, crushed, or shattered. Soft animal products and plant materials create small feather terminated scars with somewhat defined interior borders but clear terminations (Odell and Odell-Vereecken 1980). Meat, also in this soft category, produces scars that have a rougher, more irregular termination and the chips will be orientated at different angles. Striations are faint and infrequent, although polish is common and can sometimes be seen

by the naked eye. The second category is the *soft medium*. This category consists of soft woods and hard plant materials such as stalks. Chips are often fairly large, due to the tool penetrating deeply into such materials, and are hence visible to the naked eye. These scars, like the first category, are commonly “feather terminated and frequently poorly defined”. Third is the *hard medium* category. This category consists of hard woods, fish, and softened (soaked) antler and bone. Fresh bone would in addition be subsumed under this category. Scar terminations are different from the previous two, where the scars end in hinges and are medium to large in sizes. Further, polish and striations are more common in this category. The final category is that of *hard* materials. This category consists of bone, antlers, and dry /hardwoods. Scars have step terminations and are as large or larger than the third category. These scars sometimes appear on both sides of an edge and crushing commonly accompanies the scars. Striations and polish do occur but are seldom present as they are removed from the scars. Edge rounding also occurs after such tools are used for an extended period of time.

Hide working produces few microchips but considerable rounding and smoothing of the tool’s surface (Mansur 1982). Grease that accumulates through working hides cakes the working end of a scraper. This grease can act as a protective layer for the tool’s working edge and prevent microflaking (Tringham et al. 1974:184). Hides can be either soft or hard, depending on what part of a tanning process is involved. Soft hides provide large areas of contact with a tool as the hide readily gives under pressure and folds around the tool applying the pressure (Odell 1981:199). The softness and plasticity of the hide produces few microchips for this reason. Although, due to the increased surface area there tends to be a greater degree of polish, striation, and edge rounding. This contrasts with working bone and other hard materials as this produces severe microchipping (Mansur 1982:216). These types of microchips tend to be large, visible to the naked eye, with blunted edges due to the numerous microchips. Thinner-edged tools suffer more greatly than thicker-edged tools, especially when used against hard material. Pressure applied to a tool also has a positive relationship to the number of microchips created. A rule of thumb can be applied to microchipping whereby the harder the worked material, the larger and more numerous the microchips, and the more pressure applied and the thinner the edge, the more numerous the microchips (although not necessarily larger).

Woodworking produces distinctively shaped microchips. These chips, or in effect the scars left by the chips, are commonly rectangular with step terminations but sometimes have a half-moon appearance (Binneman and Deacon 1986:228). Experiments with scraping big-leaf maple wood however produced hinged flake scars (Odell and Vereecken 1980:97). The scars are commonly touching one-another or interlocking and vary in size (Odell and Vereecken 1980:97; Binneman and Deacon 1986:228). Like hides, wood can be soft to hard in texture. Soft woods like pine have some give to them, which allows the tool to penetrate the wood and have a greater amount of surface contact (Odell 1981:199). Bending fractures, or hinged microchips are common with soft woods. Indentation is decreased when a tool is used to work a hard material (Odell 1981:200). This results in a smaller zone of contact, unlike a soft material such as hide. Although, this smaller area produces a greater amount of stress as more weight and pressure is exerted upon a smaller area, which in turn results in a greater degree of wear. This explains why there is more microchipping present on a tool used on harder rather than softer materials. Furthermore, after a period of time this wear becomes “more attritional than dislocatory” in nature (Odell 1981:200).

Working harder materials, like wood, bone, and antler result in differently shaped microchips (Odell 1981:199-200). Hinge and step terminated chips are more commonly created from these materials but it should be remembered that there is overlap in the types of chips produced from either degree of hardness. Feather microchips furthermore occur during the initial working of hard materials, but these chips tend to be much larger than those created by working softer materials. The important concept is that the frequency of certain types of microchips increases or decreases with a material's hardness.

A-1.4 Rounding

Rounding is highly interconnected with the previous three forms of wear (Shea 1992:144). Rounding /dulling occurs on a tool's edge and areas on high-relief such as arris. This is an abrasion process that dulls a once sharp edge, through which material is pulled away, a subtractive process (Rots and Williamson 2004:1288). Crushing occurs in connection with rounding. Crushing is shattering and rough abrasion along a tool's surface or edge (Hayden 1979:210). The difference between crushing and rounding is

that the latter produces a smooth wear, while the former is rougher in texture. Both phenomena can be observed and characterized under the low-power approach.

Striations and microchips can overlap rounded areas and contribute to the process of rounding. Polish can also form overtop and signals that rounding occurred before polish (Dockall 1997:324). The presence of rounding attests that a tool was used for an extended period of time as the production of rounding is a slow process (Shea 1992:144). Rounding can furthermore indicate large loading pressures exerted upon a tool's edge (Shea 1992:144).

Vaughan (1985:26) organized rounding according to three facets: surface, intensity, and grit influence. Rounding on the dorsal surface of a tool's edge, facing towards the worked material, occurs from transverse actions. When the tool is used at a steep angle to the worked surface, the rounding occurs on both surfaces of the tool's edge. Fifteen percent of the time the rounding was found to be greater on the non-contact surface of the tool when used at this high angle. Similar to this though, are longitudinal motions that produce equal amounts of rounding on both surfaces of the tool's edge. When rounding occurs on both edges, but is greater on one of these surfaces, then the tool may have been "held too far off a more or less perpendicular contact angle" (Vaughan 1985:26).

Evidence of rounding on projectile points is not commonly associated with impact trauma but rather recommends that the tool was likewise used as a scraper or knife (Dockall 1997). Rounding is additionally associated with both hafting and prehension although hafting tends to produce more significant signs of rounding. Tools used for cutting or sawing experience considerable rounding on projections and other high-relief areas that contact the worked material (Odell 1981:203). These projections can develop all of the previously mentioned forms of wear, but rounding in particular occurs with the slow removal of material around the projection's tip, gradually making it duller and worn down. This is also true for the thin edges of a tool used for cutting and sawing. Intensity of rounding can indicate the length of time a tool was used or the hardness of material that the tool was used to work (Vaughan 1985:26). Although, it is difficult to quantify rounding and relate this to a measured length of time worked. This is more of a subjective, but useful, characterization that, much like the placement of rounding, when

combined with the other forms of wear. Also problematic is that the lithic material affects the rate of rounding (Vaughan 1985:26). Coarser-grain lithics take longer to develop rounding than more finely grained flints. Grit can additionally quicken the development of rounding (Vaughan 1985:26). Grit can originate from either the natural environment or from the worked material.

The amount of rounding on artifacts can be determined by measuring the widths of a dorsal ridge, or the intersection between flakes, as these are high spots (Donahue and Burroni 2000:145). In particular this was used to measure the amount of natural tumbling, but can be applied to other forms of use. At any rate, a fresh intersection should have a low to no measurement, as the peak should come to a clean point. Rounding wears these areas away and gives the peak a rounded or flat appearance. If the width reaches 5um at 200x magnification, then rolling or other natural processes may affect the tool's usewear. A caveat however, is that edge rejuvenation will remove proof of rounding and must be considered when interpreting an artifact's rounding.

A-1.5 Caveats of Usewear Studies

Usewear is a very powerful method of analysis available to archaeologists and much of its methodology is sound, but there are a few issues. This is no different from any other method in archaeology and such issues need to be addressed so that mistakes are not repeated or are avoided at the start. The discussion of caveats can too elicit new ideas regarding how to improve a methodology. Below, this final section discusses how non-intentional trauma can mimic intentional trauma, resulting in skewed usewear results and how this can be dealt with. The second topic is how usewear differs according to stone material type.

Identifying Non-Intentional Trauma

Non-intentional trauma is what Hayden (1979:217) referred to as *noise*. An important critique of usewear analyses revolves around distinguishing the noise in usewear projects. Two initial forms of noise consist of modifications to stone during tool construction, and during its incorporation into the archaeological record. Odell and Vereecken (1980:96) distinguished the latter from intentional wear by recognizing the presence of microchipping that is “usually smaller and less regularly spaced, it is often concentrated

on projecting parts of the edge and, if it occurs on a retouched edge, it tends to nick, crush, or abrade those parts of the larger scars that occur between impact or pressure points”.

Keeley (1980:4) also mentioned the importance of identifying non-intentional wear. Keeley argued that adequate controls might be used to separate the intentional from the non-intentional wear. Semenov was cited in this regard where he specifically mentioned the role of natural abrasions from wind and water. Other natural phenomena such as soil and frost actions can also create pseudo tools. Keeley (1980:4) lists three controls: experiments to recreate non-intentional wear, knowledge of what types of natural phenomena are present at a given archaeological site, and thirdly, choosing artifacts that are not in contexts where such natural wears are likely to occur. In particular Keeley (1980:6) stressed that conditions of prehistoric sites were much dirtier than the sterile atmospheres of archaeological labs in which usewear experiments occur. Further, the conditions in which artifacts are stored and handled during and after excavation must further be considered when performing a usewear study as these factors can cause unintentional wear such as *box damage* (Keeley 1980:85).

For the prehistoric contexts, there are two areas of discard: living spaces and peripheral spaces. A peripheral space is one that people do not negotiate with on a daily basis. Instead these spaces receive occasional attention, although a form of such space is consistently used: trash heaps. Trash heaps, or middens, are areas of disposal and are visited only briefly as material is added to the area (Hayden and Cannon 1983). Other peripheral spaces are brief campsites, where materials are left behind just as the inhabitant(s) are leaving, or when a material is discarded or lost en route to a living or further peripheral space. Because peripheral spaces are not visited on an ongoing basis, materials discarded at these spaces tend to be untouched by human agents until archaeologists discover the materials. Natural processes in the soil, however, do impact these materials, for example natural soil movements, ground water, or chemicals in the soil (to list a few) can all have impacts upon materials in peripheral spaces (eg. Schiffer 1976; Keeley 1980; Wilson et al. 2006). Animals can also have impacts upon artifacts, which is especially important considering the North American Plain's bison herds and

modern cattle. The types of chips that cattle create on artifacts can be easily distinguished if the researcher is aware of the artifact's context (Levitt 1979:28).

Soil Trauma

A number of factors effect a tool's wear following its abandonment. These are referred to as post-depositional noises. Soil movement and changes in soil temperature or chemical composition can obscure or alter usewear, but such modifications can further be a measure of the environment at the time of or after burial (Odell and Vereecken 1980:96; Kay 1997:653). One of the more diagnostic attributes of such noise is the random placement of the trauma on an artifact's surface (Odell and Vereecken 1980:96; Odell 1985:25).

Movements in the soil create soil polish or sheen on a buried artifact. This polish is distributed over a substantial area of an artifact (Vaughan 1985:43). This sheen often obscures underlying intentional use polishes and makes usewear analysis difficult. Soil sheens are also similar to weak polishes and this emphasizes the difficulty in interpreting intentional polishes and the importance of linking the forms of use to ensure one is speaking of intentional versus non-intentional polishes (Vaughan 1985:30).

The microchipping of an artifact's edge can additionally occur whilst buried in the soil. Soil movements and changes in the temperature, especially during wild fires, can all produce microchips (Donahue and Burroni 2000:142). Even the intentional retouching of a tool's edge can produce microchips that are similar to microchips from use. Differentiating intentional from non-intentional microchips can be difficult but possible when considering the location /patterning of the chips and that some scar shapes are indicative of intentional use. Furthermore, noting the relationship between usewear microchips and signs of retouch can reveal the artifact's use-history (Donahue and Burroni 2000:142).

Soil movement can also leave striations on an artifact's surface (Keeley 1980). These striations tend to be multidirectional and found away from an artifact's edges (Mansur 1982). Striations from soil movements are morphologically similar to those formed from intentional use but are not as numerous. Additionally, noise striations additionally tend to be lighter than culturally produced striations (Mansur 1982). Because

of the similarities between noise and intentional striations, striations must be discussed in association with other forms of wear in order to prove they are not noise (Keeley 1980).

Soil movement and water movement can too produce rounding (Vaughan 1985:26). In particular, artifacts that are rolled in water will exhibit substantial signs of rounding. This edge rounding can be more severe than what is usually associated with use. This rounding can mask the signs of other forms of wear or be mistaken for intentional wear. Natural rounding is differentiated by its placement and commonness. Intentional rounding occurs only in certain areas of a tool where it was used, while natural rounding in the case of water or soil movement will occur in numerous locations across the tool's surface.

Salt in certain environments can also alter the appearance of stone, in particular wiping away usewear evidence (Fojud and Kobusiewicz 1982). For example, a collection of 50 randomly chosen stone tools from an early Neolithic site in Egypt was submitted for usewear analysis, but no usewear was there to be found. It was reasoned that this was the product of salt that had built up in the environment in which the stone tools were deposited. In dry climates, salts can precipitate from the water and the compound's ions will latch onto the surface of a stone tool. These salt ions will then continue to dry and will have destructive consequences for the surface of a stone, and on a microscopic level there is minute flaking, shattering and general surface erosion.

Trampling

Trampling is another form of noise (Odell and Vereecken 1980:96; Keeley 1980).

Trampling can mimic usewear and even make a flake appear as a pseudotool (Shea and Klenck 1993; Odell 2001:53-4). Chips from trampling tend to be of various sizes and orientations with random distributions. Trampling especially occurs in living spaces. Ethnoarchaeological studies have documented groups who clear debris away from their living areas and dispose of it in peripheral areas (Gallagher 1977), but this is not the rule for all societies. Somewhat related to trampling is damage that results from the prehistoric transportation of tools. Depending on how this is done, erroneous usewear can result; for instance, as with Irian Jaya groups who transport their preforms wrapped in leaves (Stout 2002:698).

Damage occurs living spaces as a result of people walking atop the discarded materials. Not every setting is the same and the most crucial variable is that of substrate (McBrearty et al. 1998). This is especially problematic as most “archaeological usewear samples come from sites with hearths, flintknapping debris, architectural remains and other signs of a sustained human presence” (Shea and Klenck 1993:176). Substrate is the floor upon which a material falls upon. Two other variables, the material’s raw material and density, are found not to be of particular relevance in trampling trauma (McBrearty et al. 1998). Soft substrates produce less severe edge trauma while harder substrates produce more, but this considers only one half of the equation. The trampler’s foot itself must also be considered, for a foot clothed in a soft material will produce less trampling trauma than a foot clothed in a harder material, much like the argument for the substrate’s particularities.

Trampling produces chips along the edges of an artifact that can remove evidence of previous intentional usewear (McBrearty et al. 1998:110). Microchips from trampling are characterized by their “irregular, abrupt, or alternate edge modification, the blows often directed at nearly right angles to the edge, rather than delivered oblique to the edge as in normal retouch” (McBrearty et al. 1998:110). Striations can also be created through trampling. These striations are similar to soil movement induced striations because they run in multiple directions and are commonly are found away from an artifact’s edges (Tringham et al. 1974)

Tool Creation vs. Tool Use

Microchips from wear can be confused with edge rejuvenation scars, but there are differences in size and location /patterning of these chips (Tringham 1974:181). Even the hardest of materials have a limit on how large a microchip they can produce. Knapping can also produce trauma to a tool’s edge that has similarities to but is distinguishable from intentional usewear (Levitt 1979:29; Vaughan 1985:41-2). Retouch, in comparison to intentional usewear, tends to produce large flake scars (Odell and Vereecken 1980:96). Keeley (1980) in addition mentioned the role of manufacturing wear that can mimic usewear. A key difference is location. Wear from use is distributed across a tool’s surface, while wear from manufacturing is located only along the edge. Polishes from

antler flakers for instance are found only where a flake scar originates. Retouch also produces regularly placed flake scars that are more invasive. Crushing is additionally common at the flake origin. Crushing is the main form of wear from production (Rots and Williamson 2004:1290). Abrasive damage is also commonly associated with flintknapping along the striking platform (Keeley 1980). Along with this are deep and large striations that are commonly overlapped with the later formed signs of intentional usewear.

Contemporary Culture Induced Trauma

Archaeologically induced trauma is the damage caused to an artifact during excavation, analysis, or storage (Odell 2003:138). One of the most common types of damage from archaeologists is derived from the metal tools that are used during excavations (Donahue and Burroni's 2000:144). Damage from metal tools, thankfully, is fairly easy to identify for it appears as small and bright silver patches located on areas of high-relief. Bag-wear is caused by an artifact being stored with other objects or artifacts inside the same bag or on top of the bag. Such storage can damage the artifact, in particular by chipping the edge. Such chips are also created while screening artifacts and are non-randomly placed and orientated. These chips are also v-shaped (Odell and Vereecken 1980:96).

A second form of damage to be discussed here is the damage from agricultural equipment. This is common on archaeological sites in the Prairies. Damage to an artifact from a plow is quite large and can be seen with the naked eye (Odell 1985:24-25). Iron staining across the artifact's surface is also common and similar to the afore mentioned screen damage. Large stepped chips encompass the edges, and these chips can form a continuous line. These chips are much larger than those produced intentionally when flintknapping. Many of the chips will additionally have large v-shaped originations.

Differences of Stone Types

The vast majority of usewear literature deals with artifacts of chert, followed by obsidian, and, distantly, basalt. Although, quartzite is abundant across the Canadian Plains and has received little attention from usewear researchers (Broadbent and Knutsson 1975; Levitt 1979; Rots and Williamson 2004 are the few exceptions). Different lithic materials flake differently, and this extends to how wear traces develop on different lithic materials.

Polishes also develop differently according to lithic material types (Stemp and Stemp 2003:294). It is feasible that different lithic materials used by past cultures were chosen for their natural beauty, accessibility, and ability to withstand the tasks they were to be used in. Quartzite on the Plains may have been chosen for all three of these reasons. In distant support of this, an Archaic site from Illinois is an example where different lithic materials were used for different tool types (Odell 1993). Certain tool types such as projectile points were commonly made from particular lithic materials, while other tool types such as drills, wedges, and scrapers were made out of both local and non-local lithic materials at a relatively equal rate frequency. The number of different uses for a particular stone tool also varied according to the lithic material type.

Quartzite is incredibly hard and durable. In example, MacDonald and Sanger (1968:237) looked at over 4,000 stone artifacts, including fluted projectile points made from quartzite, chalcedony, rhyolite and metamorphosed siltstones at the Debert site in Nova Scotia. Type of use could not be fingered because of the hardness of the lithic materials. However, traces of how the tools were manufactured could be ascertained. Quartz and quartzite are difficult to study under a microscope (Levitt 1979:29; Rots and Williamson 2004:1298). A low-power approach is advocated for these materials; for example, “for quartz crystal, one is forced to rely on scarring, rounding and striations, because polish observations are difficult” (Rots and Williamson 2004:1298). Higher magnifications are inappropriate because of the heterogeneity of the lithic surface that limit how much surface area can be viewed by a microscope’s lens, but nevertheless, Knutsson (1986) had used a SEM to study his quartz artifacts. Plastic deformation, silica precipitation, and dissolution furthered quartz tool wear. As well, both a high and low-power approaches were used in this thesis. This research supported the previous argument that the low-power approach was the most fruitful as more of the surface area could be viewed, although, the high-power approach was nonetheless useful for analyzing cortex surfaces and casts for uneven surfaces.

A working hypothesis in this study is that any material will form evidence of use, for even if the tool is of a harder material than the one it works, over time the tool will still wear. Time is a crucial ingredient in forming wear, as the harder a material is, the more time it will take for it to form wear; hardness and time are therefore interrelated

variables that increase and decrease in relationship to one another. In the question of usewear on quartzite tools, this working hypothesis proposes that usewear may be less frequent on Eldon unifaces because they are of a harder material, and hence require a greater amount of time for usewear to form. Furthermore, the usewear that does form on the Eldon unifaces may differ from what is traditionally observed in usewear experiments. Polish formation may not be altered, but microchips may be different because flake scars are commonly step terminated on quartzites. In usewear studies, step terminated flake scars are conventionally considered the result of working medium to hard materials. For quartzites, however, step scars might not be indicative of the hardness of the worked material, but instead the result of the nature of the tool's lithic material when interacting with another material.

Finally, and in relation to noting the vagaries of stone types one also needs to recognize the differences in how each material is treated. It is rare that a researcher mentions whether the flesh they had cut during their experiment was previously frozen, refrigerated, or cut that day from a fresh carcass. All of these contexts can change the nature of that flesh and have an impact on the formed usewear. Pawlik (2000:170) mentioned how the working softer materials such as plants, leather or fresh hides can sometimes leave no wear traces whatsoever, unlike working harder materials such as bone, wood and antler. Skriver (2000) discussed how few researchers have experimented on cooked meats, whether roasted or smoked. What was found was that the observed wear traces, such as polish and edge rounding were similar to those from working fresh hides. Based upon their polish, Skriver discriminates between tools used on hide versus raw flesh. He argues that this polish develops fairly rapidly on flints, unlike Keeley (1980:153) who reasoned it develops much slower. Hide polish is spread over a greater area of a tool's surface than meat polish, which additionally contradicts Keeley's findings but does match Moss' (Moss and Newcomer 1982; Moss 1983) findings. Hide polish is likewise different from meat polish in that it is "relatively bright, rough polish on both the edge and the high points of the micro-topographic flint surface" (Skriver 2000:153). Meat polish is characterized by a weaker polish that is separate from a thin band of reflective polish on the tool's edge that is found on both meat and hide tools. Further to the polish, edge rounding occurs on only those tools used on hides. When flint tools were used on

cooked meats, the resultant usewear was similar to that produced by raw hides and not raw flesh. The results of this experiment were then used in a blind-test, where tools used on hide and roasted meat were examined. The results of this test indicate that less than 50% of the interpretations were correct, indicating the overlap of wear types for certain materials that are close in degree of toughness.

Raw vs. Cooked Stone

Noting differences between raw and cooked stone is another trend in recent usewear projects. Microchips on stone that was heated (cooked) have less definition than those observed on unheated (raw) stone (Gryba and Kumai 2005). Heat can affect usewear analyses by removing evidence of use as a result of spalling, cracking or crazing the tool's surface, along with reddening the surface (Donahue and Burroni 2000:145). Heat can also create a white patina on a stone tool (Donahue and Burroni 2000:145). As well, heating of certain types of silicates can increase the ease in flaking toolstone, which relates to how heated toolstone can develop microchips more readily than uncooked toolstone (Odell and Cowan 1986:202).

Stemp and Stemp (2003:294) are among the few to consider the affect of heating lithics prior to polish development: "based on measurements of stone fracture toughness on Ocala chert samples that were not heated, and samples that were heat-treated at 300, 400 and 500 degrees C, these researchers noted not only qualitative changes in texture of the fracture surface accompanying changes in toughness, but likewise changes in the fractal dimension" (Stemp and Stemp 2003:294). In relation to the heated stone is the role of hydration in toolstone manufacturing. In particular, obsidian soaked in water becomes less brittle and shatter less than when knapped in a dry state. This soaking, like cooking, may also provide different usewear results in comparison to the raw or dry stone.